UNIVERSITY CALENDAR

1923-24

1923			
September	24–October 20		Registration of graduate students Physical examination for all students
September	26	Wednesday	Fall quarter begins, 8:30* a.m.
October	11	Thursday	Examinations in German and French for candidates for all advanced degrees
November	12	Monday	A legal holiday (Sunday, November 11, Armistice Day)
November	17	Saturday	Last day for filing subject-matter of Master's thesis
November	29	Thursday	Thanksgiving Day; a holiday
December	13	Thursday	Commencement Convocation
December	20	Thursday	Fall quarter ends, Christmas vacation begins, 5:20 p.m.
1924			
January	4	Friday	Christmas vacation ends, winter quarter begins, 8:30* a.m.
January	17	Thursday	Examinations in German and French for candidates for all advanced degrees
February	12	Tuesday	Lincoln's Birthday; a holiday
February	22	Friday	Washington's Birthday; a holiday
March	21	Friday	Winter quarter ends, spring vacation begins, 5:20 p.m.
April	2	Wednesday	Spring vacation ends, spring quarter begins, 8:30* a.m.
April	17	Thursday	Examinations in German and French for candidates for all advanced degrees
April	18	Friday	Good Friday; a holiday
May	9	Wednesday	Last day for filing thesis of candidates for all advanced degrees
May	29	Thursday	Last day for filing written examinations for candidates for all advanced degrees
May	30	Friday	Memorial Day; a holiday
June	2	Monday	Last day for oral examinations for candidates for all advanced degrees
June	7	Saturday	Last day for filing bond for publication of Doctor's thesis; last day for depositing binding fee for Master's degree
June	15	Sunday	Baccalaureate service

* First hour classes begin at 8:15 at University Farm.

June	18	Wednesday	Spring quarter closes
June	18	Wednesday	Fifty-second annual commencement
June	24	Tuesday	Summer Session, first term begins
July	4	Friday	Independence Day; a holiday
July	17	Thursday	Last day for filing thesis of candidates at summer convocation
July	31	Thursday	First term, Summer Session closes
August	1	Friday	Summer Session, second term begins
September	5	Friday	Second term, Summer Session closes

THE GRADUATE SCHOOL

ORGANIZATION

The Graduate School has exclusive control of all graduate work carried on in the University. The graduate faculty is composed of those properly approved and qualified to offer courses carrying graduate credit. It determines the general educational policy of the Graduate School, and recommends candidates for degrees. The administration of the Graduate School is committed to the dean and an Executive Committee of seven members. They are assisted by group committees representing allied lines of work grouped together for administrative purposes. The groups are as follows:

a. Social Sciences and Law
b. Physical Sciences, Mathematics, and Engineering
c. Biological Sciences
d. Philosophy and Education
e. Language and Literature
f. Medicine
g. Agriculture

ADMISSION

Any graduate holding a Bachelor's degree or its equivalent from a reputable college or university will be admitted to the Graduate School without examination, and may register for such graduate work as he may be found prepared to enter upon, but he will not thereby be admitted to candidacy for either of the higher degrees until his case has been duly considered and approved.

All inquiries concerning admission to the Graduate School should be addressed to the dean. The student is advised to obtain and fill out an application for admission before presenting himself for registration.

If the rating of the institution from which he received his first degree is such that he will need a year or more of additional work before beginning graduate work at the University of Minnesota, he is advised to enter one of the undergraduate colleges of the University and obtain the preliminary training and an acceptable Bachelor's degree.

College graduates who simply desire to take additional work of undergraduate grade without a view to preparation for an advanced degree should register as unclassed students in the college giving the work.

REGISTRATION

Full directions concerning registration will be found in a booklet issued by the registrar's office for the information of new students. The essential document is an official transcript of the student's college record.

FEES

	Annual
Tuition fee (except for clinical medicine)	$30.00
Credit hour tuition for students carrying less than full work	3.00
Deposit (first quarter in residence)	3.00
Incidental fee	
Minnesota Union or Shevlin Hall	3.00
Health fee	6.00
Special fees	
Chemistry deposit	5.00

Registration in the Graduate School includes the making out of the program and paying fees for the entire year (or for the balance of the year when registration occurs after the fall quarter).

Fees must be paid not later than one week following the approval of the registration by the dean of the Graduate School in order to avoid a $2 penalty fee.

FELLOWSHIPS AND SCHOLARSHIPS

Four graduate fellowships have been established by the late Thomas H. Shevlin, of Minneapolis. These are awarded one each in the College of Agriculture, Forestry, and Home Economics, the School of Chemistry, the Medical School, and the College of Science, Literature, and the Arts. Each fellowship yields $500 per annum. They are awarded annually. Candidates for these fellowships should file their applications before March 1 with the dean of the Graduate School.

Shevlin fellows will devote their entire time to the graduate work for which they are registered, and may not engage in private tutoring or be required to render any service to the University.

CALEB DORR RESEARCH FELLOWSHIPS IN AGRICULTURE, FORESTRY, AND HOME ECONOMICS

By the bequest of the late Caleb Dorr of Minneapolis, the income from twenty thousand dollars is available for graduate fellowships in the Department of Agriculture of the University of Minnesota. Usually two fellowships of $500 each will be awarded each year. The holders of these fellowships are exempt from all tuition fees. The basis of the award is scholarship and the prospect and promise of productive research.

Caleb Dorr Fellows will devote their entire time during the academic year (nine months) to the graduate work for which they are registered and may not engage in private tutoring or be required to render any service to the University.

Candidates for these fellowships should file their applications before March 15 with the dean of the Graduate School. Application blanks may be secured from the dean of the Graduate School or from the dean of the College of Agriculture, Forestry, and Home Economics.

THE ALBERT HOWARD SCHOLARSHIP

This scholarship, founded by Mr. James T. Howard, yields $240 annually. The holder is expected to do graduate work in Liberal Arts.

THE CLASS OF 1890 FELLOWSHIP

On the twenty-fifth anniversary of its graduation the class of 1890 founded a fellowship yielding $150 and exemption from tuition. This fellowship is open to graduates of the colleges of Science, Literature, and the Arts, and Engineering and Architecture desiring to pursue advanced work. Applications should be filed with the dean of the Graduate School before March 1.

DEPARTMENTAL SCHOLARSHIPS

Besides the above stipends there are about seventy scholarships assigned to various departments, yielding $225 and exemption from tuition and fees. The holders may be required to render service not to exceed ten hours a week in laboratory or office work, or not more than three hours in classroom assistance. Where these regulations are observed, a qualified holder of one of these scholarships may become a candidate for the Master's degree on the basis of one year's work in residence.

Other assistantships and teaching fellowships, some yielding as high as $1,000 are available, but the amount of work required is greater and the length of residence of the holder of one of these appointments would be increased proportionately.

Inquiries and requests for application blanks may be addressed to the dean of the Graduate School, or to the head of the department in question.

GRADUATE WORK IN MEDICINE

Work of graduate character done in the Summer Session of the University of Minnesota under a member of the graduate faculty may be counted for residence credit for advanced degrees. The course work for the Master's degree may be completed in four summer sessions or three summer quarters. Students working for the Master's degree in summer sessions must file the subjects of their theses before the completion of the first half of the required work. Theses of summer session students must be completed at least two weeks before the end of the session in which they take the degree.

An increasing amount of graduate work in fields of interest to high school teachers is being offered in the Summer Session. The courses for any session may be found in the bulletin of the Summer Session.

Students who desire graduate credit for work in the summer must register with the dean of the Graduate School.

GRADUATE WORK IN MEDICINE

Graduate work in the laboratory departments and in the clinical branches leading to advanced degrees is offered by the University of Minnesota. This work is under the direction of the Graduate School, and candidates for admission and degrees must meet the requirements

of the Graduate School as outlined in the preceding pages. The work is offered by members of the medical faculty in Minneapolis and by members of the graduate faculty on the Mayo Foundation at Rochester, Minnesota, where part or all of the residence work may be done. Several teaching fellowships supported by the University and others on the Mayo Foundation are open to qualified students pursuing graduate work in clinical medicine or in the laboratory branches. A special bulletin on graduate work in medicine is published and may be obtained from the registrar.

WORK IN THE LAW SCHOOL

Under certain properly approved conditions graduate students may offer courses in law as a minor for an advanced degree when their major work is in the Department of Political Science or Economics.

REQUIREMENTS FOR THE MASTER'S DEGREE

The degree of master of arts is, in general, conferred for advanced non-technical study; the degree of master of science for advanced technical study, such as agriculture, industrial chemistry, engineering, etc.

The requirements for the degree of master of arts or master of science are covered in general by the statement that these degrees may be earned by properly qualified students only by at least one full academic year's work in residence at this University (three quarters). Students who have not had adequate preparation in the specific chosen field of work, or who are doing outside work in excess of ten hours a week, will require more than one year to attain the Master's degree.

Upon entrance to the Graduate School, the candidate, with the approval of the dean, will select his adviser in the field of his major work. With the approval of his adviser and the dean, he will also select a minor, and will outline a study program for the year.

Program of study.—A full program for a student who expects to meet the requirements in one academic year must cover the necessary courses in the fields of the major and minor and the preparation of a satisfactory thesis. The work must be selected from graduate courses offered in this bulletin and must amount to not less than 6 or more than 9 credit hours each quarter. In addition, thesis work (or courses upon which the thesis is based) should be carried to make a total of not less than 15 hours per week for three quarters. A grade of B at least, must be obtained in any course offered as fulfilling the requirement in the major. A grade of C must be obtained in minor courses.

The major.—The major work must be in a department in which the candidate has had at least three years of work (18 semester or 27 quarter credits) if it be a department open to freshmen, or two years of work (12 semester or 18 quarter credits) if it be a department not open to freshmen. Part or all of this preliminary work may consist of designated prerequisite courses in the same or allied departments. Any special requirements will

be noted in the corresponding departmental statement. At the end of the year, a final written examination (in addition to the usual course examinations) will be given in the major as noted below.

The minor.—The minor subject must be selected in a department in which the candidate has had at least one year's work (6 semester or 9 quarter credits), or he must have had in a closely allied department a year's work (6 semester or 9 quarter credits), which is actually designated as a prerequisite to the minor subject. Any special requirements will be noted in the corresponding departmental statements.

The choice of the minor must be in a department whose work can be logically related to that of the department in which the student is doing his major work.

The group committee may in exceptional cases allow the minor subject to be taken in the same department as that of the major.

The language requirement.—A reading knowledge of a foreign language, modern or ancient, the language to be determined by the major department, is required of candidates for the Master's degree, unless exemption is made in individual cases with the approval of the Executive Committee of the Graduate School. When no other statement is made in the departmental announcement in this bulletin, a knowledge of either French or German is expected. The candidate shall present to the dean of the Graduate School, not later than the close of the second quarter of residence, a certificate of proficiency in the designated language, signed by the professor in charge of the corresponding language department or his representative.

Candidates for the Master's degree in any department in the language and literature group who register after September 1, 1922, will be required to have a reading knowledge of two foreign languages before they are recommended for the degree.

All examinations to meet the language requirement of the Graduate School, unless otherwise arranged with the language departments, shall be held on the days specified in the calendar at the beginning of this bulletin.

A candidate who fails in a language examination for an advanced degree shall not be given a second examination until the following quarter.

The Master's thesis.—Before the middle of the first quarter in residence the candidate should file at the office of the Graduate School the subject of his thesis. This subject must be approved by his adviser and by the corresponding group committee. It should be on a topic falling within the field of the major. It is expected that the candidate will devote approximately one half his time to the preparation of the thesis, including courses on which the thesis is based. The thesis must be written in acceptable English and show ability to work independently, and give evidence of power of independent thought both in perceiving problems and making satisfactory progress toward their solution. Familiarity with the bibliography of the special field and correct citation of authorities are expected.

The thesis is required to be in triplicate in order to facilitate its consideration. One copy must be upon the specially required linen stock

and the other two may be carbon copies on cheap paper. Samples in the dean's office of both the linen stock and carbon paper should be examined before the thesis is typewritten. The body of the thesis should be double spaced, but footnotes may be single spaced.

The thesis must be finished and three copies deposited in the office of the dean of the Graduate School at least six weeks before the candidate presents himself for his degree.

The thesis will be examined by a committee of three, appointed by the dean on the recommendation of the group committee. The student's adviser will, as a rule, be the chairman of this committee. Unanimous approval by this committee will be necessary for the acceptance of the thesis.

If the thesis is accepted, the candidate must deposit with the registrar, at least one week before commencement the sum of one dollar and fifty cents for binding one copy of this thesis, which will be cataloged and deposited in the University Library.

Examinations.—All candidates for this degree will meet the regular requirements as to examinations, topics, reports, etc., of the classes in which they are registered. A special examination in the field of the minor is not required, but this does not excuse the candidate from the regular course examinations. Besides the usual course examinations, where such are given, the candidate for the Master's degree must pass a final written examination in the major and after the acceptance of the thesis, a final oral examination.

The final written examination will be held not later than four weeks before the end of the quarter in which he takes his degree. It will cover the work of the candidate in the field of the major, and may include any work fundamental thereto. This examination will be held by his instructors in the major department, the adviser acting as chairman.

If the final written examination is satisfactory, and the thesis accepted, the final oral examination of the candidate will be held, not later than two weeks before the end of the quarter in which he takes his degree. The adviser will act as chairman of the examining committee, which will include all the instructors with whom the candidate has taken work, the thesis committee, and, ex-officio, the head or chairman of the department in which the major work is done. Any member of the graduate faculty may attend as a visitor, and due notice shall be sent by the chairman of the committee to all members of the graduate faculty in the major and minor departments. The final oral examination will cover all the work offered for the degree, and may include other work fundamental thereto. At the close of the examination, the committee will vote upon the candidate, taking into account all of his work. A majority vote is required for approval.

Candidates who are eligible for the "preliminary examination" for the Doctor's degree may substitute this examination for the final oral examination for the Master's degree, provided that all other requirements for the Master's degree have been met.

Reports.—Special blanks are provided for signed reports concerning the thesis and the final oral examinations. All reports must be filed in the office of the dean of the Graduate School at least one week before the end of the last quarter.

Candidates meeting the requirements as above outlined will be reported by the dean to the graduate faculty, who will by vote recommend to the Board of Regents those approved for degrees.

Candidates upon whom degrees are to be conferred are required to be present at commencement, unless especially excused by the dean of the Graduate School and the president of the University.

TABULAR SUMMARY OF REQUIREMENTS FOR THE MASTER'S DEGREE

Work	Under the Direction of	Date
Program, major and minor	Adviser and dean of the Graduate School	On entrance
Approval of thesis subject	Adviser and group committee	Middle of first quarter in residence
Language requirement	Adviser and language department	Before close of second quarter
Approval of candidacy	Executive committee	Beginning of third quarter
Filing of thesis	Dean of the Graduate School	At least six weeks before graduation
Examination of thesis	Thesis committee	Before admission to final oral examination
Final written examination in major	Major department members of the graduate faculty	Not later than four weeks before commencement and before final oral
Final oral examination on all work	Thesis committee; all candidate's instructors; head of major department	Not later than two weeks before commencement
(Course examinations as required at the usual times.)		
Fee for binding thesis	Registrar	One week before commencement

MASTER OF SCIENCE IN ENGINEERING OR ARCHITECTURE

The requirements and procedure for the degree of master of science in civil, mechanical, electrical, chemical, or architectural engineering or architecture will correspond to those outlined for this degree in other subjects. The major subject and thesis will lie in the field represented by the degree. The thesis will be filed and final written examination taken at least six weeks before graduation. The language requirement will be waived in all of these cases except chemical engineering, in which German is required.

THE ENGINEER DEGREES

Requirements.—The advanced professional degrees, civil engineer, mechanical engineer, electrical engineer, chemical engineer, and architectural engineer will be conferred upon the recommendation of the Graduate School faculty as a result of the satisfactory completion of the following requirements:

a. A Bachelor's degree, from an approved school in the corresponding branch of engineering.

b. One full academic year of graduate engineering study (three quarters) in residence at this University. Graduates of this University may be permitted to carry on this study *in absentia* under the direction of the faculty. Work done *in absentia* may not be substituted for the residence work required for the master of science.

c. Four years of engineering experience in positions of responsibility, subsequent to receiving the Bachelor's degree. (If the graduate study is done *in absentia,* five years of experience are required.)

d. A thesis of professional grade.

Candidates for the degree of chemical engineer must have a reading knowledge of German.

For graduates of this University, a Master's degree in the corresponding branch of engineering will be accepted as fulfilling the requirements of the year of graduate study.

The Engineer degree will not be granted in less than five years after the Bachelor's degree was received.

If the Bachelor's degree is in another branch of engineering than that in which the professional degree is sought, the student must complete the equivalent of the subjects required for the Bachelor's degree in the new field before admission to candidacy for the desired degree.

The Master's degree with the Engineer degree.—It is recommended that the student who is entering upon the graduate year's study in residence for the Engineer degree register for and obtain the Master's degree for this year's work, that is, the degree of master of science in the corresponding branch of engineering. The essential difference lies in the requirement of a thesis if the Master's degree is sought. However, the aggregate amount of work is intended to be the same in both cases, namely, from 15 to 18 credit hours per week for the three quarters. If the graduate study does not lead to the Master's degree, the student is not required to prepare a thesis as a part of the year's work. The Master's thesis, however, will not satisfy the requirement for the professional thesis which is intended to be related to the practical experience after the Bachelor's degree was received.

Plan of study.—Upon entrance to the Graduate School, the candidate, with the approval of the dean, will select his adviser in the field represented by the desired degree, in which field the major work and the thesis, if one be taken, will lie. With the approval of his adviser and the dean, he will also select a minor, and will outline a study program for the year.

If the student registers for the master's degree in engineering or architecture, he will conform to the requirements for that degree as regards major and minor work, thesis, examinations, etc.

If the graduate study during the year of residence or *in absentia* is towards the Engineer's degree only, it will be divided into major and minor work, of which the major will usually constitute about two thirds

and the minor one third of the total of 15 to 18 credit hours which will be carried each quarter.

Study in absentia.—Only graduates of this University will be permitted to undertake the graduate study *in absentia* towards one of the Engineer degrees. This permission must be obtained from the head of the department represented by the degree, who will usually act as the adviser, and from the dean of the Graduate School. It is not necessary that this study be coincident with the academic year; it may be undertaken at any time.

The proposed plan of study should be arranged with the approval of the adviser. The tuition fee of ten dollars per quarter will be charged for three quarters only, altho the study may, and generally will, extend over more than nine months. At least 1,500 actual hours of work should be performed as the equivalent of a year's study in residence.

The detailed requirements of reports and examinations will be established by the adviser. A separate written report must be submitted at the end of each quarter's work. A written examination covering the entire study, both major and minor, will be held at the close of the year's work. Under favorable circumstances this examination may be held in the place where the candidate resides.

Upon the satisfactory completion of the year's work, the proper credits will be recorded towards the engineering degree.

Study in residence.—The work will consist of regular courses offered in this bulletin and may include research if desired by the student, even tho the Master's degree be not sought.

Thesis.—At least six months before the Engineer degree is expected, the thesis subject must be approved by the adviser and the group committee. The thesis itself must be filed with the dean at least six weeks before the commencement at which the degree is to be obtained together with a deposit of one dollar and fifty cents to cover binding the thesis.

Statement of experience.—With the thesis, the candidate must file a detailed statement of his professional experience since receiving his Bachelor's degree. This should amount to at least four years, if the graduate study was in residence; or five if *in absentia.*

TABULAR SUMMARY OF REQUIREMENTS FOR THE ENGINEER'S DEGREE

Work	Under the Direction of	Date
Program, major and minor	Adviser and dean of the Graduate School	On registration
Quarterly reports if in absentia	Adviser	
Written examination	Adviser and major and minor staff	At end of year's study or later, as arranged
Thesis subject	Adviser and group committee	Six months before graduation
Experience statement	Adviser and major staff	Six weeks before graduation
Filing thesis	Dean of Graduate School	Six weeks before graduation
Fee for binding thesis	Registrar	One week before graduation

Attendance at commencement.—Unless specifically excused for an important reason, the candidate will be present in person to receive the degree.

DOCTOR'S DEGREE

In the Graduate School, one Doctor's degree, doctor of philosophy (Ph.D.), is conferred by the University of Minnesota. This degree is granted, not on the basis of successful completion of a definite amount of prescribed work but solely in recognition of the candidate's high attainments and ability in this special field, to be shown, first, by the preparation of a thesis, and second, by successfully passing the required examinations covering both the general and the special fields of the candidate's subjects as detailed later.

Candidates for the Doctor's degree must devote at least three years[1] of graduate study to approved subjects. The first two years or the last year must be spent in residence at the University of Minnesota.

A member of the staff of instruction above the rank of instructor will not be permitted to enroll for a Doctor's degree at this University. There is no objection, however, to his registering for graduate work at this University and credit so obtained may be presented elsewhere.

PROGRAM OF WORK

First year.—Upon entrance to the Graduate School, the student shall select his adviser with the approval of the dean. With the approval of his adviser he shall submit to the dean a program covering his first year's work.

Second and third years.—Before beginning the work of the second year, the student shall submit to his adviser and the group committee for approval a tentative outline of his work for the second and third years, including both the major and minor subjects. This program is then to be submitted to the dean for final approval. During the second quarter of the second year he shall file with his adviser's approval the subject of his Doctor's dissertation.

Language requirements.—Before admission to the preliminary examination, the student must present to the dean of the Graduate School statements from the French and German departments, certifying that the applicant has a reading knowledge of those languages. The substitution of other foreign languages of greater service in the major field may

[1] This time requirement will be met in three years only by those students who devote all their time to graduate study. Students who merely devote the intervals of professional or other regular employment to graduate study will need to extend their total period of work over a longer period of time. Credit for such work will be given in proportion to the amount of time actually spent in the pursuit of graduate work.

be permitted by the executive committee on recommendation of the group committee. In addition, a knowledge of other languages may be required in certain cases, as the candidate's major department may prescribe. The student's adviser or his representative shall attend the language examinations and provide literature in the major field from which the test passages are selected. For the dates of these language examinations consult the calendar at the beginning of this bulletin.

THE MAJOR WORK

The major work must be in a department in which the candidate has had, in his undergraduate study, at least three years of work (18 semester or 27 quarter credits) if it be a department open to freshmen, or two years of work (12 semester or 18 quarter credits) if it be a department not open to freshmen. Part or all of this preliminary work may consist of designated prerequisite courses in the same or allied departments.

During the period of work for the Doctor's degree a student shall spend not less than two thirds of his time[1] on the major subject, including the work on the thesis. During the last two years, he shall carry an average of at least one course per quarter in his major outside the work from which this thesis is developed.

At the close of the second year's work, and before admission to the preliminary examination, the student must obtain the written recommendation of the major department members of the graduate faculty. Such written recommendations should state that in view of the work already done by the applicant, the department is convinced of his probable capacity and ability to meet all the requirements for the degree, including the thesis, the subject of which must be stated.

In the case of a student who comes for the last year of residence only, provision for the examination will be made by the dean and the major department.

THE MINOR WORK

The minor work must be selected in a department in which the student is prepared to pursue courses advanced enough in character to be included in the group designated "For Undergraduate and Graduate Students," and numbered 100 or above.

The choice of the minor must be in a department the work of which can be logically related to that of the department in which the student is doing his major work.

In exceptional cases, the dean and the group committee may allow the minor subject to be taken in the same department as that of the major or in two related departments.

[1] In estimating the distribution of time, a week of 15 credit hours may be assumed.

Not less than one sixth of the total work of the three years shall be devoted to the minor subjects and all of this work shall be completed and certified to by the department in which the minor is taken before admission to the preliminary examination.

THESIS

The thesis, for which the accumulation of material may well be started not later than the beginning of the second year, must give evidence of originality and power of independent investigation, and embody results of research, which form a real contribution to knowledge as well as exhibit mastery of the literature of the subject and familiarity with the sources of knowledge. The matter must be presented with a fair degree of literary skill.

Not later than six weeks before the commencement at which he expects to take the degree, the student shall deposit at the dean's office his thesis, typewritten, in triplicate copy to facilitate reading by the thesis committee. The requirements concerning form, copyrighting, and printing adopted in June, 1922, may be consulted in the Graduate School office.

The dean will appoint a thesis committee with the student's adviser as chairman. The duty of this committee will be to read the thesis and vote upon its acceptance. Unanimous approval by this committee will be necessary to such acceptance.

Printing of the thesis.—If the thesis be accepted, the student shall deposit with the registrar, not later than one week before graduation, a sufficient bond or such sum of money as is needed to print one hundred copies of the thesis for the use of the University and as many additional copies as the candidate may require for himself. If the thesis is to be published elsewhere, reprints will be acceptable, if bound with covers in the special form required by the University.

EXAMINATIONS

Preliminary.—After the language examination (see p. 16) and at least seven months before the degree is conferred, a preliminary examination of the student shall be given by a committee appointed by the dean and including the student's adviser as chairman, a representative of the group committee other than his adviser, the chairman or head of the major department, a representative of the minor department, and such other members as the dean may consider advisable. Certificates of proficiency in French and German and completion of the minor and the recommendation of the major department shall be required before admission to this examination. The examination shall cover graduate work previously taken by the student, and *may include any work fundamental thereto,* except the thesis and the field of definite specialization. This examination shall be in addition to the usual course examinations. It may be written or oral, or both, at the discretion of the committee. Only after the successful completion of this examination may the student be enrolled as a candidate for the Doctor's degree. Students failing to

pass this preliminary examination may be excluded from candidacy for the degree and in any case shall not be re-examined until at least one quarter has passed.

Final written.—After the thesis is presented, and at least four weeks before examination, there shall be a written examination in the major subject, to be given by the members of the graduate faculty in the major department. This examination shall cover all the work done in the major, and *may include any work fundamental thereto.*

Final oral.—After successful completion of the written examination and acceptance of the thesis and not less than two weeks before graduation, the final oral examination shall be given. This examination shall be conducted by a committee consisting of the adviser as chairman, of a majority of the members of the graduate faculty of the department in which the major work was done and at least three other members of the graduate faculty appointed by the dean. At least one member of this committee shall be from a group other than the one in which the major department is included. This examination has special reference to the thesis and the field of the candidate's special studies and shall not exceed three hours.

The date of the final oral examination shall be publicly announced and the examination shall be open to any member of the graduate faculty. Upon completion of the examination, a formal vote of the committee shall be taken, and an affirmative vote of at least two thirds of the members shall be necessary for recommendation of the candidate for the degree.

Reports.—Special blanks are provided for signed reports concerning the thesis and the final oral examinations. All reports must be filed in the office of the dean of the Graduate School at least one week before graduation.

Candidates meeting the requirements as above outlined will be reported by the dean of the graduate faculty, who will by vote recommend to the Board of Regents those approved for degrees.

Candidates upon whom degrees are to be conferred are required to be present at commencement, unless especially excused by the dean of the Graduate School and the president of the University.

TABULAR SUMMARY OF REQUIREMENTS FOR THE DOCTOR'S DEGREE

Work	Under the Direction of	Date
First Year		
Major	Adviser and dean of the Graduate School.....	On registration
Minor		
Second Year.		
Tentative program of entire second and third year's work	Adviser, group committee, and dean of Graduate School	Before beginning work of second year
Major, including thesis...	As for tentative program	
Minor	Adviser and minor department	Before admission to preliminary examination
Language	Adviser and language department	
Recommendation	By major department....	
Preliminary examination..	Special committee.....	Seven months before degree is to be conferred
Third Year		
Major, including thesis...	Advisers, group committee, and dean of Graduate School	
Filing of thesis.....	Dean	Six weeks before taking the degree
Examination of thesis.....	Thesis committee.....	Before admission to final oral examination
Final written examination	Major department members of the graduate faculty	Four weeks before taking degree and before final oral examination
Final oral examination....	Advisers, majority of members of major department, and other members appointed by dean of Graduate School.....	Not later than two weeks before taking the degree
Bond for publication of thesis	Registrar	Not later than one week before taking the degree

DESCRIPTION OF COURSES

EXPLANATIONS

A *dagger* (†) indicates that all quarters of a course must be completed before credit is received for any quarter.

AGRICULTURAL BIOCHEMISTRY

Professors Ross Aiken Gortner, Clyde H. Bailey, Leroy S. Palmer; Associate Professor John J. Willaman; Assistant Professors Cornelia Kennedy, Clarence A. Morrow.

Prerequisites.—For major work, credit in general chemistry and qualitative analysis, in organic chemistry, in quantitative analysis, and at least ten quarter credits in biological science. The work presented as prerequisite must be satisfactory to the instructor with whom the student wishes to work.

For minor work, credit in general chemistry and qualitative analysis, in organic chemistry, and 10 quarter credits of biological science. Minors should be arranged only after consultation with the instructors concerned.

Candidates for the Master's degree must have a reading knowledge of German or French. (In special cases, where other languages are needed for the development of the thesis, Russian, Italian, or the Scandinavian languages may be substituted.)

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

101f-102w. Agricultural Quantitative Analysis. Includes estimation of inorganic and organic constituents of biological products, proximate analysis of foods and feeding stuffs, and the use of special apparatus. Prerequisite: quantitative analysis. Three credits each quarter. V, VI, VII; MWF; 7Ch. Mr. Morrow.

103s. Dairy Chemistry. Lectures and laboratory work on the physical, colloidal, and chemical properties of milk and dairy products, and of the processes involved in the manufacture of dairy products. V, VI, VII; MWF; 7Ch. Mr. Palmer.

108s. Chemistry of Wheat and Wheat Products. A lecture course, with collateral library reference work, on the chemical technology of the production and milling of wheat and its conversion into food. Prerequisite: organic chemistry. Three credits. I; MWF; 201Ch. Mr. Bailey.

109s. Selected Flour Laboratory Methods. A laboratory course in which particular attention is given to recently developed methods for testing wheat products. Less extensive than 110. Designed for men with commercial laboratory experience. Prerequisite: Course 101-102 or

Chemistry 131-132, parallel 108. Three credits. V, VI, VII, VIII; MW; 7Ch. Mr. Bailey.

110s,su.[1] Flour Laboratory Methods. A laboratory course. Analysis of wheat and its products. Designed to train students for research in the cereal industry. Prerequisites: Course 101-102 or food analysis. Five credits. V, VI, VII, VIII; MWF; 7Ch. Mr. Bailey.

111f,su-112w,su. Phytochemistry. An advanced course dealing with the colloidal state, and the chemistry of proteins, carbohydrates, glucosides, tannins, fats, plant acids, enzymes and pigments, and their physicochemical relations to the vital processes involved in growth and nutrition. Prerequisites: organic chemistry, biology, 1 year. Three credits each quarter. III; MWF; 201Ch. Mr. Gortner.

113f,su-114w,su-115s. Biochemical Laboratory Methods. A laboratory course paralleling the lectures in 111-112. Prerequisite: quantitative analysis, parallel 111-112. Two or 3 credits each quarter. V, VI, VII, VIII; TTh; 7Ch. Mr. Morrow.

116w. Advanced Animal Nutrition. Recent developments in animal nutrition, covering the field of proteins, mineral metabolism, vitamines, and the relation of nutrition to disease. Prerequisite: Course 15 or equivalent. Two credits. III; TTh; 351Ch. Mr. Palmer, Miss Kennedy.

117f,w,s,su. Laboratory Problems in Animal Nutrition. A laboratory course on methods used in nutrition studies. (Because of limited laboratory facilities, students planning to register for this course should obtain permission from the instructors before registration.) Prerequisite: Course 116. Three to 5 credits. Ar. Mr. Palmer, Miss Kennedy.

118f,w,s,su. Laboratory Problems in Biochemistry. Special laboratory work in the preparation and isolation of pure compounds, and in special methods of identification or determination of biochemical products. Prerequisites: Courses 111-112, 113-114; or 103 or 110. Three or 5 credits. Mr. Gortner, Mr. Bailey, Mr. Palmer, Mr. Willaman, Miss Kennedy, Mr. Morrow.

COURSES PRIMARILY FOR GRADUATE STUDENTS

201f,w,s. Seminar. Regular meetings for the discussion of methods of research, formulation of research problems, and reviews of current literature. Required of all majoring in this division and of all minoring for the Doctor's degree. One credit. Mr. Gortner.

203f,w,s,su. Research Problems. Special work on particular research problems other than the student's major thesis. Facilities are provided

[1] Offered in alternate summers. Not offered in 1924.

for biochemical investigations and for advanced studies in plant, animal, or human nutrition. Three or 5 credits. Mr. Gortner, Mr. Bailey, Mr. Palmer, Mr. Willaman, Mr. Morrow.

205f,w,s,su. Special Topics in Biochemical Literature. Library work followed by the preparation of written reports upon either the historical development or the current literature of special biochemical problems. A reading knowledge of German is necessary and of French desirable. Prerequisite: Course 206, 207, or 208. Three credits. Mr. Gortner, Mr. Bailey.

206f. Colloids. Lectures dealing with the colloidal state, the preparation and properties of colloidal solutions, and the relation of these to biochemical processes. Prerequisite: Course 111-112, or physical chemistry. Three credits. II; MWF; 351Ch. Mr. Gortner.

207f. Enzymes.[1] Lectures dealing with the nature of enzyme action, including methods of preparation and investigation of enzymes, their physical and chemical properties and their methods of action. Prerequisites: Course 111-112, or physiologic chemistry. Three credits. III; MWF; 351Ch. Mr. Willaman.

208w. Proteins.[1] Lectures on the composition, structure, biochemical reactions, and functions of the protein and amino acids with special emphasis upon those which are concerned in plant growth and metabolism, animal food, and industrial processes. Prerequisite: Course 111-112, or advanced organic chemistry. Three credits. II; MWF; 351Ch. Mr. Willaman.

209w. Carbohydrates.[2] A lecture and library course on the synthesis, structure, reactions, and functions of carbohydrates, with especial reference to those which are of plant or animal origin and which play a rôle in biochemical or industrial processes. Prerequisite: Course 111-112, or advanced organic chemistry. Three credits. II; TThS; 351Ch. Mr. Willaman.

212w,su. Special Topics in Nutritional Chemistry. A course comprising lectures, independent library study, and oral presentation by students, of special assigned topics in animal nutrition. A reading knowledge of German is essential and French desirable. Prerequisite: Course 116. Three credits. Mr. Palmer.

AGRONOMY AND FARM MANAGEMENT

Professors Andrew Boss, Herbert K. Hayes; Associate Professors Albert C. Arny, Fred Griffee.

Prerequisites.—In agronomy, for major work, Courses 121, 122, 131, 132, or their equivalents, and a reading knowledge of German or French.

[1] Offered in alternate years. Offered in 1923-24.
[2] Offered in alternate years. Not offered in 1923-24.

For minor work, two years of botany, one year of zoology, and the elementary courses in farm crops.

In farm management, for major work, Courses 102, 103, and 104, or their equivalents, and at least 6 credits in elementary and agricultural economics. For minor work, at least 12 credits in the elementary agricultural sciences (Farm Crops 1, Soils 4, and Animal Husbandry 3-4). Exemption from the language requirement for the Master's degree may be made in individual cases.

In plant-breeding, for major work, Courses 121, 122, 131, 132, or their equivalents, and a reading knowledge of German or French. With the approval of the adviser, courses in agricultural biochemistry, botany, farm crops, horticulture, plant pathology, and plant physiology, may be accepted as major work. For minor work, two years of botany, one year of zoology, and the elementary courses in farm crops. Students majoring in plant breeding are required to continue study during at least one summer. Exemption is made if similar training has been obtained at some other institution.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

In Agronomy

121f. Cereal Crops. An advanced study of the cereal crops. Structure, group classification, improvement, growing, and utilization. Brief score card practice and a limited amount of placing on intrinsic value included. Prerequisites: Farm Crops I, botany, 10 credits. Three credits. VI, VII; TTh; 2 Ad(F). Mr. Arny.

122w. Corn and Potato Crops. A study of the corn and potato crops similar to that outlined for cereal crops. Prerequisites: Farm Crops I; botany, 10 credits. Three credits. V, VI, VII; TTh; 2 Ad(F). Mr. Arny.

123s. Forage and Fiber Crops. A study of the forage crops through assigned reading, laboratory and field work. Prerequisites: Farm Crops I, botany, 10 credits. Three credits. V, VI, VII; TTh; 2 Ad(F). Mr. Arny.

133w. Judging and Grading Farm Crops. Prerequisites: Agronomy, Farm Management, and Plant Breeding I, 121, 122. Course 122 may be concurrent. VIII; TTh; 2 Ad(F). Mr. Arny.

In Farm Management

102f,w,s. Farm Management I: Organization. The business side of farming and farm organization and equipment is emphasized. Prerequisites: Farm Crops I, Economics 5, Soils 4. Three credits. II; MWF; 24 Ad(F). Mr. Boss.

103w,s. Farm Management II: Organization. A continuation of Course 102 with special attention to farm operation. Prerequisites: same as above with Agronomy, Farm Management, and Plant-Breeding 102. Three credits. I; MWF; 24 Ad(F). Mr. Boss.

104s. Farm Management III. A methods course, covering cost of production studies, farm business analysis, farm practice and farm management literature. Prerequisites: Agronomy, Farm Management, and Plant-Breeding 102 and 103. Three credits. II; MWF; 18 Ad(F). Mr. Boss.

In Plant-Breeding

131f,w. Principles of Genetics. Given in co-operation with the Division of Horticulture. Designed to familiarize students with underlying principles of breeding. Prerequisites: Botany, 10 credits; or animal biology, 10 credits. Three credits. I; ThS; I, II; T; 24 Ad(F). Mr. Griffee, Mr. Beaumont.

132s,su. Farm Crops Plant Breeding. Applied genetics is emphasized. Prerequisites: Agronomy, Farm Management, and Plant-Breeding 131. Three credits. I; ThS; I, II; T; 4 Ad(F). Mr. Griffee.

COURSES PRIMARILY FOR GRADUATE STUDENTS

In Agronomy

209Ar. Research in Farm Crops. It is desirable that students remain during one summer to work out research problems. Prerequisites: 9 credits in farm crops. Mr. Arny.

213f,w. Farm Crops Seminar. Weekly meetings for the discussion of current literature and for reports of thesis problems. Prerequisites: 9 credits in farm crops. Maximum of 3 credits. Mr. Arny.

214Ar. Special Topics in Farm Crops Literature. Technique in conducting experimental work and interpreting results. Library work, including the making of abstracts, reviews, and bibliographies. Prerequisites: Agronomy, Farm Management, and Plant-Breeding 121, 122, 123, and a reading knowledge of German. Maximum of 6 credits. Mr. Arny.

In Farm Management

205f. Farm Business Analysis. Special and intensive work in studying the various factors entering into farm organization. Prerequisites: 9 credits in farm management. Three credits. Ar. Mr. Boss.

207w. Cost of Production Studies. Prerequisites: 9 credits in farm management. Three credits. Ar. Mr. Boss.

215w,216s. Advanced Farm Organization. Analysis of farm organization and the application of survey factors and cost factors in organizing the business of farming. Prerequisites: 12 credits in farm management. Three credits. Ar. Mr. Boss.

In Plant-Breeding

201Ar. Research in Plant-Breeding. May be taken as a major or minor work. Prerequisites: Agronomy, Farm Management, and Plant-Breeding 131, 132. Mr. Hayes.

203f,w,s. Plant-Breeding Seminar. History, recent genetic theories, and a discussion of research problems. Weekly meetings throughout the year. Prerequisites: Agronomy, Farm Management, and Plant-Breeding 131. 3 credits. Mr. Hayes.

211w. Topics in Plant-Breeding. Emphasis is given to field plot technique, the results of inbreeding and outbreeding, and the results of selection and crossing as a means of improving crop plants. Practice in outlining the correct mode of attack for special plant breeding problems. Prerequisites: Agronomy, Farm Management, and Plant-Breeding 132. Minimum of 3 credits. Maximum of 6 credits. Mr. Hayes.

217f. Advanced Genetics. Current genetic literature. Linkage, genetic stability, chromosomal aberrations, and the probable errors of Mendelian ratios will be emphasized. Prerequisites: Agronomy, Farm Management, and Plant-Breeding 131, or Horticulture 109. Minimum of 3 credits. Maximum of 6 credits. Mr. Hayes.

ANATOMY

Prerequisites.—The Institute of Anatomy offers excellent facilities to students who wish to take advanced work or to pursue investigations in anatomy.

The prerequisite work for all students for major or minor in the Department of Anatomy includes general zoology (animal biology), 6 credits, and advanced zoology or elementary courses in anatomy (including histology, embryology, and neurology), 6 credits. In addition each student desiring a major in anatomy must have had the elementary courses in that branch of anatomy in which he desires to specialize—gross anatomy, histology, embryology, or neurology.

For staff and the description of courses, see the special bulletin on graduate work in medicine.

ANIMAL BIOLOGY

Professors Henry F. Nachtrieb, Hal Downey, John B. Johnston, William A. Riley, Arthur G. Ruggles, Charles P. Sigerfoos; Associate Professors Elmer J. Lund, Royal N. Chapman; Assistant Professors Harry H. Knight, Dwight E. Minnich, Oscar W. Oestlund.

Prerequisites.—For major work, Course 1-2 and at least 18 credits of advanced work approved by the department; for minor work, Course 1-2 or the equivalent.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

107s. Protozoology. Lectures, references, and laboratory work on the structure and life histories of Protozoa. Three credits. I, II; MWF; 211,213AB. Mr. Sigerfoos.

109f,110w,111s. General Physiology. A thoro survey of fundamental physiological processes in organisms. Based on Bayliss's *Principles of General Physiology*. Laboratory, lectures, and reading. Fifteen credits. V-VIII; MWF; 10AB. Mr. Lund.

117f-118w-119s.† Ecology of Insects. General principles of ecology with special reference to the insects of Minnesota. Lectures, laboratory, assigned reading, and field work. Nine credits. V-VII; TTh; 202AB. Mr. Chapman.

124su. Advanced Ecology. Similar to Course 117-118-119 with special field work. Five credits. Ar. 202AB. Mr. Chapman.

125f-126w-127s.† Advanced Entomology. Morphology and classification of insects, with lectures on the history of entomology. Nine credits. III, IV; TThS; 204AB. Mr. Oestlund.

130w. Biology and Taxonomy of the Aphididae. Intensive study of the natural history, bibliography, and classification of the Aphididae. Three credits. III, IV; MWF; 204AB.

139-140.† Histology and Development of Insects. Lectures and laboratory work on the histology, embryonic and postembryonic development of insects. Six credits. II, III, IV; T and ar.; 324AD(F). Mr. Riley.

144f-145w-146s. Animal Parasites and Parasitism. Lectures and laboratory work. Origin and biological significance of parasitism; the structure, life history, and economic relations of representative parasites. Second term devoted primarily to the relation of insects to diseases of man and animals. Nine credits. V-VII; WF; 202AB. Mr. Riley.

149f-150w-151s.† Blood of Vertebrates. A comparative study of blood and blood-forming organs of vertebrates. A portion of time to be devoted to research. Nine credits. Ar.; 201,211AB. Mr. Downey.

181f-182w.† General Embryology. Principles and laws of animal development in connection with origin and development of germ cells, sex chromosomes, fertilization, cleavage, etc. Six credits. V, VI; MWF; 201,211AB. Mr. Nachtrieb.

183s.† Genetics and Eugenics. Facts and theories of heredity and the application of the laws governing natural inheritance for the improvement of the race. Three credits. IV; MWF; 211AB. Mr. Nachtrieb.

197f-198w-199s. Problems. Advanced work in some special line. Nine or 18 credits. Hours and days arranged. Mr. Nachtrieb, Mr. Downey, Mr. Johnston, Mr. Riley, Mr. Sigerfoos, Mr. Lund, Mr. Chapman, Mr. Minnich, Mr. Oestlund.

COURSES PRIMARILY FOR GRADUATE STUDENTS

201-204. Research in Entomology. Hours and days arranged. Mr. Riley, Mr. Chapman, Mr. Knight, Mr. Oestlund, Mr. Graham.

205-208. Research in Economic Entomology. Mr. Ruggles, Mr. Graham.

209-212. Research in Economic Vertebrate Zoology. Mr. Washburn.

213-216. Research in Biological Oxidations. Mr. Lund.

217-218-219. Research in the Physiology of the Lower Organisms with Special Reference to the Protozoa. Mr. Lund.

225-228. Research of the Gross and Microscopic Anatomy of the Ganoids. Mr. Nachtrieb.

229-232. Research in Animal Histology. Mr. Downey.

233-236. Research in Vertebrate Connective Tissue with Special Reference to the Cellular Elements. Mr. Downey.

237-238. Research in Vertebrate Hematology. Mr. Downey.

245-248. Comparative Neurology. A study in the structure and functions of the nervous system of vertebrate animals and of the evolution of the chief nervous mechanisms. Prerequisites: two years in comparative or human anatomy. Mr. Johnston.

249-252. Research in Neurology. Mr. Johnston.

253-254. Dynamics of Protoplasm and Cells. Physical and chemical interpretation of the structure of living protoplasm, and vital processes such as permeability, secretion, enzyme action, regeneration, stimulation, and energy transformation in the living cell. Research accompanied by lectures. Mr. Lund.

257-260. Sensory Physiology of Invertebrates. Mr. Minnich.

261-264. Research in Parasitology and Medical Entomology. Mr. Riley.

265-268. Research in Insecticides.

ANIMAL HUSBANDRY

Professors Walter H. Peters, Evan F. Ferrin; Assistant Professors Phillip A. Anderson, H. W. Vaughan.

Prerequisite.—Students majoring in this division are exempted from the language requirement for the Master's degree.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

101f. Advanced Livestock-Judging. Three credits. VI, VII; MWF; center arena, St(F). Mr. Ferrin.

102s. Horse Husbandry. Stud farm management; the selection of foundation stock and the breeding, feeding, and marketing of horses. Horsepower; factors determining a horse's efficiency for work. Three credits. II; TTh; 3St(F) and V, VI, VII; F, center St(F). Mr. Peters.

103s. Beef Cattle Husbandry. The management of purebred and grade herds of beef cattle, sales and shows, building equipment, labor, with practical exercises. Three credits. III; MW; 3St(F) and V, VI, VII; T; BB. Mr. Vaughan.

104s. Sheep Husbandry. Similar in method to 103, with practice in shearing, blocking, feeding, and caring for lambs. Three credits. IV; WF; 3St(F) and V, VI, VII; M; center St(F). Mr. Anderson.

105s. Swine Husbandry. Topics of 103 as applied to swine production, marketing, costs, feeding, etc. Three credits. III; TS; 3St(F) and V, VI, VII; Th; center St(F). Mr. Ferrin.

106w. Advanced Meats. Practice work in dressing animals and cutting carcasses; also a study of the chemical composition of meat. Three credits. V, VI, VII; WF; Meat Shop. Mr. Anderson.

107s. Meat Problems. The wholesale cuts and grades of meat, the packing industry and utilization of by-products, special problems and visits to meat-packing establishments. IV; TS; and V, VI, VII; W; Meat Shop. Mr. Anderson.

108s. Seminar. Special assignments and review of investigations pertaining to the livestock industry. Three credits. II; MWF; 3St(F). Mr. Peters.

COURSES PRIMARILY FOR GRADUATE STUDENTS

201. Advanced Study of Livestock-Breeding. Studies of the methods followed in the building up of breeds of livestock and distinguished blood lines within the breeds. Review of scientific literature on livestock-breeding. Three to 10 credits. Mr. Peters.

202. Advanced Livestock-Feeding. A study of experimental results bearing upon feeding questions and review of scientific literature applicable to them. Three to ten credits. Mr. Ferrin.

203. The Marketing of Livestock. A study of the methods used in the principal markets of the world. Three credits. Mr. Vaughan.

204. Advanced Study of the Breeds of Livestock. A study of the history, development, characteristics, and blood lines in any of the leading breeds of livestock. Three credits. Mr. Peters, Mr. Ferrin, Mr. Anderson, Mr. Vaughan.

205. Experimental Methods. Theory, plan, and conduct of experimental work in animal husbandry. Factors affecting results, sources of error, interpretation of data. Three credits. Mr. Ferrin.

ANTHROPOLOGY[1]

Professors Albert Ernest Jenks,[2] Wilson D. Wallis.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

108s. Philippine Peoples. Comparative study of the four large ethnic and cultural groups in the Philippine Islands; policy of the insular government as it affects American home interests in the Orient. II; MWF; 25F. (Not given in 1923-24.) Mr. Jenks.

110. Physical Anthropology and Amalgamation. Mr. Wallis.

112f. The American Negro. Development of the American negro; his characteristics, conditions, and developing tendencies. Negro and immigrant adjustments. Prerequisites: three courses. Three credits. IV; MWF; 15F. (Not given in 1923-24.) Mr. Jenks.

113f. The American People—Older Immigrants. Characteristics, contributions, and distribution of the older immigrant peoples in America, their modification and importance. Prerequisites: three courses. Three credits. III; MWF; 15F. (Not given in 1923-24.) Mr. Jenks.

114w. The American People—Newer Immigrants. Prerequisites: three courses. Three credits. III; MWF; 15F. (Not given in 1923-24.) Mr. Jenks.

115s. American People—Americanisms and Assimilation. Essential and unique historical Americanisms. Conditions and facts of assimilation. Prerequisites: three courses. Three credits. III; MWF; 15F. (Not given in 1923-24.) Mr. Jenks.

116s. African Ethnology. Prerequisites: Anthropology 51 or 62. Three credits. Mr. Wallis.

[1] Courses in Americanization alone may not be offered as a major for an advanced degree.

[2] On leave, 1923-24.

121w. Advanced Physical Anthropology. Prerequisites: physical anthropology, anatomy, or comparative anatomy. Three credits. Mr. Wallis.

123f-124w. Problems in Anthropology. An advanced course of method and independent research. Six credits. (Not given in 1923-24.) Mr. Jenks.

128f,s. Technique of Teaching Adults. Methods of teaching adults—the foreign-speaking, the illiterate, the fatigued. Prerequisites: three courses. Three credits. I; MWF; F. (Not given in 1923-24.)

129w. Methods of Americanization. Practical methods of Americanization in use in the United States. Prerequisite: Course 128. Three credits. I; MWF; F. (Not given in 1923-24.) Mr. Jenks.

130s. Organization and Administration of Americanization Work. Existing Americanization organizations of federal, state, municipal, and neighborhood groups. Methods of organizing new groups. Prerequisite: Course 128. Three credits. I; MWF; F. (Not given in 1923-24.) Mr. Jenks.

131f-132w-133s. Supervised Americanization Work. Practical field work among foreign peoples in our vicinity. Prerequisites: three courses. Nine credits. VI; T and ar.; 12F. (Not given in 1923-24.)

141f-142w-143s. Principles of Adult Elementary Education. Prerequisite: Course 128. II; MWF; 12F. (Not given in 1923-24.)

150f-151w-152s. Field Problems in Americanization. An advanced course of method and independent research. Prerequisite: Course 128. Six credits. IV; MWF; 12F. (Not given in 1923-24.)

160f. Primitive Ethics. Ethical ideas and moral standards of primitive peoples. Prerequisites: Anthropology 51, or Ethics 3. Three credits. Mr. Wallis.

162s. Primitive Religion. Religious ideas and practices of primitive peoples. Prerequisites: Anthropology 51, or 62, or Philosophy 102. Three credits. Mr. Wallis.

COURSES PRIMARILY FOR GRADUATE STUDENTS

204f-205w-206s. Seminar in Anthropology. Individually directed research. Prerequisites: three courses. Three credits each quarter. Ar. 12F. Mr. Wallis.

ARCHITECTURE

Professors Frederick M. Mann, Leon E. Arnal.

COURSES

119f,w,s. Special Researches in Architectural History. Prerequisite: completion of undergraduate architectural history. Five credits or less per quarter. III; MW; 320ME. Mr. Mann.

139f,w,s. Advanced Architectural Design. Prerequisite: completion of undergraduate design. Ten credits or less per quarter. VI, VII, VIII, IX; MTWThF; I, II, III, IV; S; 317ME. Mr. Arnal.

ASTRONOMY

Professor Francis P. Leavenworth; Assistant Astronomer William O. Beal.

The Astronomical Observatory contains a ten and one-half inch refracting telescope furnished with a third lens for converting it into a photographic telescope; a five-inch star camera; a filar micrometer; a spectroscope by Brashear; a meridian circle and zenith telescope; a Repsold photographic measuring machine; a chronograph, and astronomical clocks.

Prerequisites.—For major work, Course 51-52-53 and Mathematics 50; for minor work, Mathematics 50 and 3 credits in astronomy.

Exemptions from the language requirement for the Master's degree may be made in individual cases.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

101f-102w-103s. Practical Astronomy. Theory and use of astronomical instruments; astronomical photography, with measures of plates; study of method of least squares. Prerequisite: Mathematics 50. Three to 6 credits. III; MWF. 124F. Mr. Leavenworth.

111f-112w-113s. Celestial Mechanics. Prerequisite: Mathematics 51. Three credits. Ar. Mr. Beal.

140w. Method of Least Squares. Applied especially to engineering, physics, and astronomy. Prerequisite: Mathematics 51. Three credits. II; TThS; 124F. Mr. Leavenworth.

COURSES PRIMARILY FOR GRADUATE STUDENTS

201f-202w-203s. Advanced Practical Astronomy. Prerequisite: Astronomy 101-102. Three credits. Mr. Leavenworth.

204f-205w-206s. Astrophotography. Prerequisite: Astronomy 102. Three credits. Mr. Leavenworth.

208f-209w-210s. Calculation of Orbits. Prerequisite: Mathematics 51. Three credits. Mr. Beal.

BOTANY

Professor C. Otto Rosendahl, Josephine E. Tilden; Associate Professors Frederic K. Butters; Rodney B. Harvey; Assistant Professor William S. Cooper.

Note.—For courses in plant pathology and mycology, see Department of Plant Pathology.

Prerequisites.—For major work, 36 quarter credits in botany; for minor work, 20 credits.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

107w. Morphology and Taxonomy of Bryophytes. Structure and classification of liverworts and mosses. Prerequisites: Courses 7 and 62. Five credits. Ar. 106AB.

108w. Morphology and Taxonomy of Pteridophytes. An intensive study of lycopods, ferns, and their allies. Prerequisites: Courses 7 and 62. Five credits. Ar. 4AB. Mr. Butters.

110w. Morphology and Taxonomy of Gymnosperms. An intensive study of cycads, conifers, and their allies. Prerequisites: Courses 7 and 63. Five credits. Ar. 4AB. Mr. Butters.

113f-114w-115s. Advanced Taxonomy. Special attention is given to the taxonomy of different natural groups of angiosperms. Prerequisites: 15 credits including Course 7. Nine credits. VI, VII; MWF; 213AB. Mr. Rosendahl.

118w. Cytology. A study of the origin, development, structure, and functions of the plant cell and its various constituents. Prerequisites: 18 credits. Three credits. VI, VII, VIII; TTh; 213AB. Mr. Rosendahl.

123-124f-125w-126s. Morphology and Taxonomy of the Algae. Advanced studies in selected groups. Prerequisites: 15 credits including Course 12 for each course. Three credits for each course. VI, VII, VIII; TTh; 104AB. Miss Tilden.

Any of the above courses may be taken separately.

(123 not offered in 1922-1923.)

127s. Anatomy of Vascular Plants. The microscopic structure of vascular plants with particular attention to the development and evolution of the vascular system in the root, stem, and leaf. Prerequisites: 18 credits. Five credits. III, IV; MTWFS; 213AB. Mr. Butters.

131f. Field Ecology. A survey of the local plant communities and successions, and a study of the general principles of plant association and succession. Prerequisite: Course 21. Five credits. Ar. Ar. G. Mr. Cooper.

132w. Ecological Anatomy. The individual plant and its parts as related to environment; special plant forms and structures, their causes and significance. Prerequisite: Course 21. Five credits. III, IV; MTWFS; G. Mr. Cooper.

133s. Forest Geography of North America. Preliminary discussion of the principles of plant distribution followed by a detailed study of the forest regions of North America. Prerequisite: Course 21. Five credits. VI, VII; MWF; G. Mr. Cooper.

141. Physical Phases of Plant Physiology. The intake and translocation of materials, and the energy relations of the plant. Prerequisites: Course 22 and general organic chemistry. Five credits. I, II; MTWThF; G. Mr. Harvey.

142w. Plant Metabolism. The synthesis of plant food, its transformation and utilization by the plant. Prerequisites: Course 22 and general organic chemistry. Five credits. I, II; MTWThF; G. Mr. Harvey.

143s. Plant Metabolism and Growth. A continuation of Course 142, dealing with respiration, growth, and movement. Prerequisites: Course 22 and general organic chemistry. Five credits. I, II; MTWThF; G. Mr. Harvey.

144f or s. Plant Microchemistry. A study of the location of materials of physiological importance in the plant and their relation to physiological processes. Prerequisites: Course 22 and general organic chemistry. Five credits. Ar. Ar. G. Mr. Harvey.

COURSES PRIMARILY FOR GRADUATE STUDENTS

201-202-203. Research Problems in the Morphology of Vascular Plants. Mr. Butters.

205-206-207. Research Problems in the Taxonomy of Angiosperms. Mr. Rosendahl.

209-210-211. Research Problems in Algae. Miss Tilden.

213-214-215. Research Problems in Embryology. Mr. Butters.

217-218-219. Special Research Problems in the Taxonomy and Distribution of Algae. Miss Tilden.

221-222-223. Research Problems in Ecology. Mr. Cooper.

224. Research Methods in Plant Physiology. Mr. Harvey.

225-226-227. Research Problems in Plant Physiology. Mr. Harvey.

229-230-231. Research Problems in Cytology. Mr. Rosendahl.

233-234-235. Seminar. Students may register for one-hour seminar credit per quarter in any of the above research subjects.

CHEMISTRY

Professors Paul H. M.-P. Brinton, George B. Frankforter, William H. Hunter; Associate Professors Everhart P. Harding, Frank H. MacDougall, M. Cannon Sneed; Assistant Professors Lillian Cohen, Isaac W. Geiger, Lawrence M. Henderson, Lloyd H. Reyerson, Lee I. Smith.

In addition to the completion of the prescribed work, the candidate for a higher degree is expected to show a maturity acquired by intensive personal study of the literature and of the methods of chemistry.

Prerequisites.—(a) Chemistry as a major subject: All candidates who choose chemistry as a major subject for the Doctor's degree must offer the following courses or their equivalent as prerequisites: at least 12 quarter credits in general inorganic chemistry and qualitative analysis, at least 10 credits in quantitative analysis, and at least 10 credits in organic chemistry. All candidates must present at least one year of college physics or one year of college mathematics. (b) Chemistry as a minor subject: It is not possible to state exactly those courses which will be required in each case. If the major is not chosen in chemistry, the usual prerequisites will be at least 12 credits of general inorganic chemistry and qualitative analysis and 5 credits of quantitative or 5 credits of organic chemistry.

Students may not select two branches of chemistry as major and minor subjects except with the approval of the graduate faculty in the School of Chemistry.

The choice of the particular courses to be presented in fulfillment of a minor will be made after consultation with the student's adviser. Either Analytical Chemistry, Courses 120-121, or Organic Chemistry, Courses 135-136-137 will be acceptable as a minor for the Master's degree, or for not more than one half of a minor for the Doctor's degree, if the student is not taking major work in chemistry.

Language requirements.—Candidates for the Master's degree must have a reading knowledge of German or French; German is preferred. For the Doctor's degree both are required.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

General Inorganic Chemistry

101s. History of Chemistry. The theories of chemistry from the period of the ancients, with particular emphasis on modern theories and laws. Prerequisite: Course 36. Two credits. Miss Cohen.

102w. Advanced Qualitative Analysis. Includes an analysis of minerals, alloys, paints, and the methods of detecting some of the rarer elements. Prerequisite: Course 21. Two or three credits. Mr. Sneed.

103f-104w-105s. Advanced Inorganic Chemistry. A discussion of valence, the periodic system, and the chemistry of the elements—their laws, theories, and compounds. Prerequisites: Courses 21, 36. Three credits per quarter. Lect., IV; TThS; 111C. Mr. Sneed.

Analytical Chemistry

120w-121s. Quantitative Analysis. General principles, methods, and procedure both gravimetric and volumetric. Typical problems; laboratory practice. Prerequisite: Course 13. Five credits per quarter. Lect. VI; M; 325C. Rec. VI; F; 315C. Lab. VI-IX; MWF; 310C. Mr. Geiger, Mr. Sarver.

123f. Advanced Analytical Chemistry. Analytical methods for the determination of the common constituents of iron ore, iron, and steel are discussed and compared, with emphasis upon the general principles involved. Typical problems with laboratory practice. One lecture and seven laboratory hours per week. Prerequisite: Course 21 or 27 or 28. Three credits. Lect. VI; T; 315C. Lab. VII-IX; T; VI-IX; Th. Mr. Sarver.

124w. Advanced Analytical Chemistry. A survey of the methods of analytical chemistry applied to the analysis of minerals and ores. One lecture and 7 laboratory hours per week. Prerequisite: Course 21 or 123. Three credits. Lect. VI; T; 315C. Lab. VII-IX; T; VI-IX; Th. Mr. Brinton, Mr. Geiger, Mr. Sarver.

125s. Advanced Analytical Chemistry. Selection may be made to meet the particular needs of the student from the following: silicate analysis, non-ferrous alloy analysis, water analysis, problems in electroanalysis, etc. One lecture and 7 laboratory hours per week. Prerequisite: Course 21 or 123. Three credits. Lect. VI; T; 315C. Lab. VII-IX; T; VI-IX; Th. Mr. Sarver.

127f-128w-129s. Chemistry of the Rare Elements. Chemical relations and general reactions of rarer elements not considered in general courses. Analyses of commercially important ores and compounds of these elements are made. One lecture and 6 laboratory hours per week. Prerequisite: Course 21. Three credits per quarter. Mr. Brinton.

227f-228w-229s. Selected Topics in Analytical Chemistry. Analytical problems of an advanced nature presenting special difficulties will be selected for study and investigation in the laboratory, in the library, and by conference. Open only to graduate students who have had 18 credits of quantitative analysis, and who have a reading knowledge of French and German. Two, 3, or 4 credits per quarter. Mr. Brinton.

Organic Chemistry

131s. Organic Analysis. Practice in the identification of organic compounds, and the modern methods of qualitative organic analysis. Prerequisite: Course 37. Three credits. Mr. Lauer.

132w. The Rise and Development of Organic Chemistry. Includes biographical and other phases necessary to a complete discussion of the subject. Prerequisite: Course 37. Two credits. Mr. Frankforter.

133f. Reagents in Organic Chemistry. Their limits of applicability, methods of use, and types of substances with which they react. May be accompanied by appropriate laboratory work in Chemistry 138. Prerequisite: Course 37. Three credits. Mr. Smith.

134f. The Terpenes. Includes the bicyclic compounds and their important substitution products. May be accompanied by appropriate laboratory work in Chemistry 138. Prerequisite: Course 37. Two credits. Mr. Frankforter.

135f-136w-137s. Organic Chemistry. Full discussion of aliphatic and aromatic series with preparation of some of the more important compounds; other work of special nature will also be required. Offered to graduate students taking their minor in chemistry. Prerequisite: Course 13. Five credits per quarter. Lect. III; MWF; 325C. Lab. VI-VIII; TTh; 390C. Mr. Hunter.

138f,w,s. Advanced Organic Chemistry Laboratory Work. Students may also register for this course who desire appropriate laboratory work for other advanced courses. Prerequisite: Course 37. Two to five credits. Lab. ar; 390C.

139f,w,s. Advanced Organic Chemistry Laboratory Work. An introduction to research work. These advanced laboratory courses may be taken under any member of the Division of Organic Chemistry. Prerequisite: Course 37. Two to five credits. Lab. ar; 390C.

191f-192w-193s. Advanced Organic Chemistry. An introduction to the literature of organic chemistry. Structure, reaction mechanism, and relation of physical properties to constitution. May be accompanied by appropriate laboratory work in Chemistry 138-139. Prerequisite: Course 37. Three credits per quarter. III; TThS; 325C. Mr. Hunter.

231f-232w-233s. Organic Chemistry Seminar. One hour a week. Open only to students taking research in organic chemistry. One credit. Mr. Hunter.

Physical Chemistry

140f-141w-142s. Physical Chemistry. A general survey of the subject. Three lectures and one recitation. Laboratory work three to six hours per week. Prerequisites: two years college dentistry, 1 year college physics. Three, four, or five credits, depending on the amount of laboratory work. Lect. IV; MWF. Rec. IV; S. Lab. VI-VIII; WF. Mr. MacDougall.

143f,w. Physical Chemistry. Designed chiefly for medical and biological students. Prerequisite: Course 32. Four credits. Mr. Henderson.

243f-244w-245s. Thermodynamics and Chemistry. Prerequisites: Course 142 and calculus. Three credits per quarter. Mr. MacDougall.

246f-247w-248s. Kinetic Theory and Atomistics. Kinetic theory of gases and liquids, crystal structure, structure of atom, quantum theory. Prerequisites: Course 142 and calculus. Three credits per quarter. Lect. II; TThS. (Not offered in 1923-24.) Mr. MacDougall.

149s. Principles of Colloidal Chemistry. Prerequisites: Course 141 and calculus. Two credits. (Not offered in 1923-24.) Mr. Reyerson.

150s. Application of Colloidal Chemistry. Prerequisite: Course 141. Two credits. Mr. Reyerson.

151s. Radiochemistry. The occurrence, methods of isolation, and physicochemical properties of the radioactive substances, together with a brief consideration of the chemical, geological, and biological bearing of the subject. Prerequisite: Course 141. Two credits. (Not offered in 1923-24.) Mr. Henderson.

152f,w,s. Laboratory Course in Radiochemistry. To accompany or follow Course 151. Credits arranged. Mr. Henderson.

253f-254w-255s. Advanced Physical Chemistry Laboratory. To accompany or follow any of the advanced courses in physical chemistry. Prerequisite: Course 142. Credits arranged. Mr. MacDougall.

156w. Applications of Physical Chemistry to Organic Chemistry. Illustrations of the use of physicochemical methods in organic research. Prerequisites: Courses 130 and 142. Three credits. Mr. Henderson.

157f-158w-159s. Colloid Chemistry Laboratory. Credits and hours to be arranged. Must be preceded or accompanied by Physical Chemistry 149 or 150. Mr. Reyerson.

250f-251w-252s. Physical Chemistry Seminar. One hour a week. For students taking advanced courses in physical chemistry. One credit. Mr. MacDougall, Mr. Henderson, Mr. Reyerson.

Technological Chemistry

161f-162w-163s. Food Analysis. Prerequisite: Course 21. Three credits per quarter. Lect. IV; T; 215C. Lab. II-III, VI-IX; F; 217C. Mr. Harding.

164w. Exact Gas Analysis. Prerequisite: Course 21. One or two credits. Mr. Harding.

166s. Microchemistry. Chemical methods and the microscope applied to minute quantities of substances and the examination of food materials, fibers, etc. Prerequisite: Course 21. One or two credits. Mr. Harding.

167f. Gas and Fuel Analysis. The chemical analysis and colorimetry of solid and gaseous fuels and methods of testing municipal gas. Prerequisite: Course 21. Three credits. Lect. I; S; 215C. Lab. I-III; TTh; 10C. Mr. Harding.

168w. Petroleum and Petroleum Products. Examination and testing principally of gasoline, illuminating and lubricating oils. Prerequisite: Course 21. Three credits. Lect. I; S; 215C; I-III; TTh; 10C. Mr. Harding.

169s. General Technical Analysis. Includes a large range of topics: textiles and paper, paints and varnishes, asphalt and tars, boiler waters, soaps, edible oils and fats, and various other food materials and food products. Prerequisite: Course 21. One, two, or three credits. Mr. Harding.

COURSES PRIMARILY FOR GRADUATE STUDENTS

301f-302w-303s. Research Work in Inorganic Chemistry. Credits to be arranged. Mr. Sneed, Mr. Henderson, Mr. Reyerson.

321f-322w-323s. Research Work in Analytical Chemistry. Credits to be arranged. Mr. Brinton, Mr. Geiger.

331f-332w-333s. Research Work in Organic Chemistry. Credits to be arranged. Mr. Frankforter, Mr. Hunter, Mr. Smith.

341f-342w-343s. Research Work in Physical Chemistry, Including Work in Electrochemistry, Radiochemistry, and Colloids. Credits to be arranged. Mr. MacDougall, Mr. Henderson, Mr. Reyerson.

361f-362w-363s. Research Work in Technological Chemistry. Credits to be arranged. Mr. Harding.

CHEMICAL ENGINEERING

Professors Charles A. Mann, George B. Frankforter; Assistant Professor George H. Montillon.

Prerequisites.—Before being admitted to major work in chemical engineering, the student should have received the Bachelor's degree in chemical engineering or its equivalent. If he has not met this requirement, it will be necessary for him to pursue such additional preparatory studies as may be prescribed by the adviser.

The student selecting chemical engineering as a minor must present as prerequisites mathematics including integral calculus, physics, analytical and organic chemistry, and mechanical drawing.

Requirements.—For the degree of master of science in chemical engineering, the major subject and the thesis must be taken in chemical engineering.

Students may not select chemical engineering in combination with any branch of chemistry as major and minor subjects except with the approval of the group committee.

The candidate for the Master's or the Doctor's degree with chemical engineering as a major must have completed, as undergraduate or graduate, a year's work in physical chemistry, such as, for example, Courses 140f-141w-142s, or their equivalent.

For the requirements for the professional degree of chemical engineer, see page 14.

Languages.—Candidates for the Master's degree in chemical engineering must have a reading knowledge of German or French; German is preferable in this field. For the Doctor's degree, both are required.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

171s. Chemical Machinery. Principles and materials of construction, operation and uses of chemical machinery. Lectures and recitations. Laboratory work in operating and testing. Visits to chemical plants. Prerequisites: Courses 21, 36. Four credits. I; MTWThF; 111C. Mr. Mann.

172f. Industrial Inorganic Chemistry. Operations common to chemical industries, marketing of products, utilization of by-products, trade journals. Lectures and recitations. Prerequisite: Course 171. Four credits. I; MTWThF; 111C. Mr. Mann.

173w. Industrial Organic Chemistry. Similar to above but covering organic field. Lectures and recitations. Prerequisite: Course 172. Four credits. I; MTWThF; 111C. Mr. Mann.

174f. Chemical Manufacture. (Inorganic.) Manufacture of technical products on a scale large enough to afford data for the determination of cost of manufacture. Use of semi-plant scale equipment and technical trade journals. Laboratory. Prerequisite: Course 171. Two or more credits. Mr. Mann, Mr. Montillon.

175w. Chemical Manufacture. (Organic.) Similar to above but covering the organic field. Laboratory. Prerequisite: Course 171. Two or more credits. Mr. Mann, Mr. Montillon.

176f-177w. Applied Electrochemistry. Application of the electric current to chemical processes. Laws and phenomena of electrochemistry, batteries, electroplating, electric furnace construction and operation, and

electrolytic and electric furnace products. Prerequisite: Course 142. Four credits per quarter. Lect. III; MWF; IIIC. Lab. VI-VIII; Th. MR. MANN, MR. MONTILLON.

178s. CHEMICAL ENGINEERING CALCULATIONS. Problems in drying, evaporation, filtration, and general chemical processes. Prerequisite: Course 173. Three credits. Lect. III; MWF; IIIC. MR. MONTILLON.

179s. ADVANCED APPLIED ELECTROCHEMISTRY. The more recent developments in this field. Prerequisites: Courses 142, 176, 177. Four credits. MR. MANN, MR. MONTILLON.

180f-181w-182s. DESIGN OF CHEMICAL EQUIPMENT AND PLANTS. Based on collected data on the subject. Classroom and laboratory work. Prerequisite: Course 173. Two credits per quarter. VI-VIII; MF. MR. MANN, MR. MONTILLON.

183f. CHEMISTRY OF EXPLOSIVES. History, development, manufacture, and uses. Lectures, required reading, and reports. Prerequisite: Course 173. Four credits. MR. FRANKFORTER.

184s. ORGANIC DYESTUFFS. The technical chemistry of commercial dyes and their intermediates. Class and laboratory. Prerequisite: Course 173. Five credits. MR. FRANKFORTER.

185s. ADVANCED CHEMICAL MANUFACTURE. Problems in the manufacture of special chemicals on a large scale, using the industrial chemistry laboratory. Prerequisites: Courses 174, 175. Three credits. MR. MANN, MR. MONTILLON.

186s. GAS MANUFACTURE AND DISTRIBUTION. Prerequisites: Chem. 21 and 27. Three credits. MR. MONTILLON.

271f-272w-273s. SEMINAR. Presentation and discussion of papers concerning the newer developments in chemical industries. One credit. MR. MANN, MR. MONTILLON.

COURSES PRIMARILY FOR GRADUATE STUDENTS

371f-372w-373s. RESEARCH WORK IN CHEMICAL ENGINEERING—INDUSTRIAL INORGANIC AND INDUSTRIAL ORGANIC CHEMISTRY—APPLIED ELECTROCHEMISTRY, ELECTRIC FURNACE WORK, AND CHEMICAL MANUFACTURE. Credits to be arranged. MR. MANN, MR. FRANKFORTER.

CIVIL ENGINEERING

Professors FREDERIC H. BASS, ALVIN S. CUTLER, FREDERICK M. MANN, JOHN I. PARCEL, FRANK B. ROWLEY; Assistant Professors FRED C. LANG, GEORGE A. MANEY.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

For prerequisites see bulletin of College of Engineering and Architecture.

121f. Railway Engineering. Design and construction of railroad buildings and tracks. Method of computing earthwork, and estimates and reports. Three credits. Mr. Cutler.

122w. Railway Engineering. Train resistance, grades, curvature, distance, rise and fall, as factors in location and operation of railroads. Train-loading, acceleration, retardation; locomotives and equipment. Operating costs governing grade revision. Three credits. Mr. Cutler.

123s. Railway Engineering. Lectures, office work, and field inspection. Design and operations of various types of yards and terminals, and terminal facilities. Signalling and interlocking. Three credits. Mr. Cutler.

124w. Transportation. Operating problems of railway, highway, ocean, and inland waterway transportation. Typical design and equipment. Cost and value of service, valuation, regulation, present systems, and organizations. Three credits. Mr. Cutler.

125s. Transportation. Specific illustrative problems: Twin City and Mississippi Valley traffic situation, Mississippi River experiment, New York Barge Canal, Great Lakes traffic, St. Lawrence River project, Panama Canal status. Rapid transit, motor transport. Aerial transport. Three credits. Mr. Cutler.

131f. Bridge Analysis. Stresses in simple span railway bridge trusses of the larger type. Four credits. Mr. Maney.

132w. Bridge Design. Design and detail drawing of railway plate girder viaduct. Three credits. Mr. Maney.

133s. Bridge Design. Complete design and detail drawing of railway pin truss span. Three credits. Mr. Maney.

134s. Statically Indeterminate Structures. General theory deflections and statically indeterminate stresses and their application to continuous girders, frames, swing bridges, redundant members. Three credits. Mr. Parcel, Mr. Maney.

146f,w,s. Cement and Concrete Laboratory. Laboratory technique and experimental investigation of special problems in cement, concrete, and reinforced concrete. Three credits. Mr. Lagaard.

161f. Hydrology. Rainfall, evaporation, transpiration, percolation, run-off. Flood and low water flows of streams. Storage problems. Three credits. Mr. Bass.

162w. Water Supply Engineering. Sources of supply. Laboratory methods of testing water; wells, surface water intakes, conduits and pipe lines, distribution systems, and purification plants. Selection of pumping machinery and motive power. Three credits. Mr. Bass.

163s. Sanitary Engineering. Quantities of sewage and storm water; precipitation and run-off. Sanitary sewer system for a small community; storm water system for a city district. Steam pollution and sewage disposal. Three credits. Mr. Bass.

164w-165s. Water Power. Types of low, medium, and high head developments. Details of developments. Types of dams. Turbine settings and characteristics. Three credits. Mr. Bass.

171f. Building Sanitation. The location and orientation of buildings; lighting, ventilation, water supply, plumbing, sewage, and refuse disposal. Two credits. Mr. Bass.

COURSES PRIMARILY FOR GRADUATE STUDENTS

221f-222w-223s. Railway Administration. An analysis of railway organization and methods of management and operation. Principles of valuation and rate-making. Three credits. Mr. Cutler.

224. Railway Terminals and Yards. A continuation of Course 123. Three credits. Mr. Cutler.

261s. Water and Sewage Purification. Continuation of Course 163. Design of water purification and sewage disposal. Three to five credits. Mr. Bass.

262. Water Supply Problems. Continuation of Course 162. Three to five credits. Mr. Bass.

251s. Highway Laboratory. Investigation in co-operation with State Highway Department. Three to five credits. Mr. Lang.

252. Highway Administration. Problems of highway administration and finance. Three to five credits. Mr. Lang.

271. Building Sanitation. A design course in the sanitation of buildings. Heating and ventilating, plumbing, lighting. Housing problems. Three to five credits. Mr. Bass, Mr. Rowley.

272. City-Planning. The physical elements of the city; topography, drainage, geology. Public works and structures. Street arrangements; rapid transit; railroad terminals. City-districting. Subsurface structures. Esthetic features of the city; the civic center; parks; boulevards; public buildings. Three to five credits. Mr. Bass, Mr. Mann.

234f-235w-236s. Advanced Structural Design. Fundamental theory of stresses applied to special problems. Relative economy in design. Comparative study of specifications. Three to five credits per quarter. Mr. Parcel.

237-238. Structural Laboratory. Similar to 234, but dealing mainly with experimental problems in structural steel. Strain gauge study of actual stress distribution in beams, columns, and riveted joints. Three to five credits per quarter. Mr. Maney, Mr. Lagaard.

245f-246w-247s. Advanced Reinforced Concrete Analysis. Critical review of the literature of reinforced concrete and study of the advanced theory. Study of test data and analysis of stresses in reinforced concrete structures. Three to five credits per quarter. Mr. Maney, Mr. Lagaard.

280f-281w-282s. Civil Engineering Research. Original work along lines of plain and reinforced concrete, structural steel, hydraulics, municipal and transportation problems. Investigations, reports, tests, designs. Five credits per quarter. Mr. Bass, Mr. Cutler, Mr. Parcel, Mr. Lang, Mr. Maney, Mr. Lagaard.

COMPARATIVE LITERATURE

Professor Oscar W. Firkins.

COURSES

101-102-103.† Drama. An outline of the history of drama, including the drama of to-day. Lectures and readings. III; TThS; 113F. Mr. Firkins.

105-106-107.† Principles of Criticism. Lectures and readings. VI; MWF; 113F. Mr. Firkins.

110. The International Romantic Movement in Europe (1775-1825). II; TThS; 113F. Mr. Firkins.

203. The Arthurian Legend: from Geoffrey of Monmouth to Tennyson and Wagner. Mr. Firkins.

206. French and English Literary Criticism: from the sixteenth century to the present time. Mr. Firkins.

COMPARATIVE PHILOLOGY

Professor Frederick Klaeber; Associate Professor Samuel Kroesch.

Prerequisites.—This department besides offering courses in the general principles of linguistic science, affords an opportunity for elementary studies in comparative Indo-European philology, and more particularly the investigation of Old Germanic dialects. Related courses in English philology will be found under English Language and Literature.

As a matter of course, candidates for the Master's degree must have a knowledge of Latin and German; candidates for the Doctor's degree must have a knowledge of Greek also.

Students are advised to confer with the department before selecting courses.

COURSES FOR UNDERGRADUATES AND GRADUATE STUDENTS

101f-102w. General Introduction to the Science of Language. Prerequisite, one of the following groups: (1) five years' foreign language, four may be in high school and one in college; (2) two years' foreign language. Three credits. IV; 205F. Mr. Klaeber.

103f. Universal Language. Comparison of families of languages grammatically and lexically. Movement for creation of an international language. Prerequisites same as for Course 101. Three credits. IV; TS; 205F. Mr. Klaeber.

105s. The Life of Words. Etymology, and semasiology. Growth of vocabulary; change of words in form and meaning. Prerequisites same as for Course 101. Three credits. VI; TTh; 205F. Mr. Klaeber.

108f. Comparative Phonetics. A study of speech sounds and the nature of their production with especial reference to English, French, and German. Open to students of the modern languages. Prerequisites: 2 credits in other than elementary courses. This course is identical with German 108. Three credits. Hours to be arranged. Mr. Kroesch.

109f-110w-111s. History of the German Language. Identical with German 109-110-111. Nine credits. Hours to be arranged. Mr. Klaeber.

141f-142w-143s. Historical Grammar of the English Language. I. Sounds and spelling. II. Accidence and syntax. Nine credits. Hours to be arranged. Mr. Klaeber.

COURSES PRIMARILY FOR GRADUATE STUDENTS

202. Comparative Grammar of the Greek, Latin, and Germanic Languages. A general survey of the field of Indo-Germanic philology will be included.

203-204. Gothic. The relation of Gothic to other Germanic dialects will be particularly emphasized. Study of the grammar, reading of texts, discussion of problems. Mr. Klaeber.

205. Urgermanische Grammatik. Lectures and study of standard works. Mr. Klaeber.

207-208. Old Saxon. Old Saxon grammar; interpretation of the *Heliand* and *Genesis*. Mr. Klaeber.

209-210. Old High German. Braune's *Althochdeutsche Grammatik;* Braune's *Althochdeutsches Lesebuch.* This course is identical with German 209-210. Mr. Klaeber.

211-212. Research Seminar. Competent graduate students will be advised and assisted in research along special lines. Mr. Klaeber.

DAIRY HUSBANDRY

Professors Clarence H. Eckles, Joseph R. Keithley; Assistant Professor Allan B. Rayburn.

Students taking their major in dairy husbandry may be exempted from the language requirements for the Master's degree.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

101f. Milk Production. Problems of the dairy farmer with laboratory work. IV; MTWFS; 39DH. Mr. Eckles.

102s. Market Milk. Lectures and laboratory work. IV; MW; II, III; Th; 39DH. Mr. Keithley.

103w. Dairy Stock-Feeding. Application of the principles of nutrition to special problems of feeding the dairy cow and growing the young animals. III; MWF; 30DH. Mr. Eckles.

104f. Advanced Study of Dairy Breeds. Practice in comparative judging; selection and valuation; visits to purebred herds. VI, VII, VIII; MW; 40DH. Mr. Rayburn.

105f-106w-107s. Seminar. Special investigation and study of selected topics. Reports on assigned subjects and reviews recent scientific investigations. II; S; 30DH. Mr. Eckles.

111f. Dairy Products I. The chemical, bacteriological and economic problems in the manufacture and marketing of butter and ice cream. Laboratory exercises. I; MW; II, III; Th; 39DH. Mr. Keithley.

112s. Dairy Products II. Similar to 111f with special application to cheese, condensed milk, and milk powder. Laboratory exercises. IV; TF; VI, VII; T; 39DH. Mr. Keithley.

COURSES PRIMARILY FOR GRADUATE STUDENTS

202f-203w-204s. Research in Dairy Husbandry. Facilities offered for study and investigation of subjects pertaining to dairy cattle. Students are allowed to assist at times with investigations under way in the experiment station. Arranged to meet the needs of the individual student. 30DH. Mr. Eckles.

205f-206w-207s. Dairy Products. Opportunity and facilities are offered for the study and investigation of problems concerning common dairy products. The work is arranged to meet the needs of the individual student. Mr. Keithley.

ECONOMICS

Professors George W. Dowrie, John D. Black, Roy G. Blakey, Frederic B. Garver, Norman S. B. Gras, Alvin H. Hansen, Bruce D. Mudgett; Associate Professors H. Bruce Price, Clare L. Rotzel, J. Warren Stehman, Holbrook Working; Assistant Professors Ernest A. Heilman, Walter R. Myers, John J. Reighard; Professorial Lecturer J. Franklin Ebersole; Instructor Harry J. Ostlund.

Candidates for higher degrees will be accepted as majors in economics in the following fields: money and banking, public finance, economic theory, economic history, labor statistics, agricultural economics (marketing, land economics, farm finance, economics of agricultural production, agricultural prices); in accounting only for the Master's degree.

GENERAL ECONOMICS

Prerequisites.—For major work, 27 quarter credits for those offering Economics 1-2, or Economics 20-21, or their equivalent; 18 quarter credits for those not presenting one of these courses or an equivalent. These credits should include Money and Banking, Statistics, and Accounting. Candidates not presenting these fundamental courses upon registration in the Graduate School may be required to complete them in addition to the regular course requirements for the degree.

Majors and minors.—Major and minor work for the Master's degree may both be taken in economics if the candidate presents a program of courses properly complementing each other and not too closely related, if approved by the Executive Committee of the Graduate School. Agricultural economics, economic history, and accounting will usually be considered satisfactory as majors or minors distinct from general economics.

Required courses.—All candidates for advanced degrees must complete Economics 103-104, or Economics 203-204-205, or the equivalent of either. Other courses will be required according to the field in which the candidate is working. Ordinarily at least one full graduate seminar must be carried throughout the year.

Language requirement.—Candidates for the Master's degree in economics are required to have a reading knowledge of a foreign language only when the thesis is written in the following fields: money and banking, public finance, economic theory, economic history, and labor.

AGRICULTURAL ECONOMICS

Prerequisites.—For major work 18 quarter credits. If, however, these credits do not include courses in Money and Banking, Statistics, and Accounting, these may be required in addition to the regular course requirements for the degree. Farm Management II and III may be included as economics prerequisites.

Majors and minors.—Upon approval of the graduate faculty, candidates doing their graduate work in agricultural economics may take their minor in general economics.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

103f-104w. Value and Distribution. Six credits. VII; MWF; 102B. Mr. Garver, Mr. Working.

105s. History of Economic Ideas. Three credits. VIII; MWF; 102B. Mr. Garver.

106w. Land Economics. Land as a factor of production; rural and urban land utilization; rents and land values; land classification; land exchange. Three credits. II; TThS. Mr. Black.

106s. Land Economics. Three credits. VII-VIII½; TTh; 202B. Mr. Black.

107s. Land Tenure. Property in land; tenancy; farm labor; evolution of the tenure classes. Three credits. VII; MWF. Mr. Black.

108w. Marketing of Farm Products. Three credits. VIII; MWF; 102B. Mr. Price.

112f. Business Statistics. Three credits. II; TThS; 202B. Mr. Mudgett.

113w-114s. Theory of Statistics. Six credits. II; TThS; 213B. Mr. Mudgett.

115f-116w-117s. Economics of Agricultural Production. Two credits. IV; TS. Mr. Black.

118f-119w-120s. Economic History of Europe and the United States, 1750 to the Present. (See History 113-114-115.)

121f-122w-123s. Economic History of Europe, 1300-1750. (See History 116-117-118.)

126f. Principles of Co-operation. Three credits. I; TThS. Mr. Black.

127w-128s. Marketing Organization and Management. Principles of accounting and business organization applied to the organization and management of proprietary and co-operative marketing business units. Six credits. III; MWF. Mr. Price.

131f-132w-133s. Cost Accounting. Nine credits. (1) II; TThS; 109B(f,w) 303B(s). (2) III; TThS; 109B(f,w) 303B(s). Mr. Ostlund.

134f. Income Tax Accounting. Three credits. II; MWF; 202B. Mr. Reighard.

135w-136s. Auditing. Six credits. II; MWF; 209B. Mr. Reighard.

137f-138w-139s. Accounting Practice and Procedure. Nine credits. (1) III; MWF; 109B(f,w) 303B(s). (2) IV; MWF; 102B. Mr. Heilman.

143f-144w, 143w-144s. The Financial System. Eight credits. Fall to winter. Lecture IV; T; Lit.Th. (1) VIII; MTW; 209B. (2) II; MWF; 109B. (3) III; MWF; 202B. (4) II; TThS; 213F. (5) III; TThS; 209B. (6) VI; MWF; 209B. (7) III; MWF; 302D. (8) II; MWF; 322F. Winter to spring, Lecture IV; S; 202B. (1) III; MWF; 105F. (2) IV; MWF; 105F. (3) VII; MWF; 213B. Mr. Dowrie and others.

145s. Foreign Exchange. Three credits. II; TThS; ar. Mr. Myers.

146f. Investments. Three credits. IX; MTW; 209B. Mr. Ebersole.

147s. Bank Administration. Three credits. IX; MTW; 209B. Mr. Ebersole.

149w,s. Business Cycles. American business conditions since 1890 with regard to the great cycles of alternate prosperity and depression and financial panics. Critical examination of all the available business barometers designed to forecast similar conditions. Three credits. Winter, IX; MTW; 209B. Spring, VIII; MTW; 209B. Mr. Ebersole.

150s. Advanced Farm Finance. Three credits. Mr. Dowrie.

153w. The Trust Problem. Three credits. II; MWF; 213B. Mr. Stehman.

154s. Public Utilities. Three credits. I; MWF; 102B. Mr. Reighard.

155s. Corporation Finance. Three credits. Lect. III; S. Mu.Aud. (1) II; TTh; 2F. (2) III; TTh; 102B. (3) III; MW; 202B. (4) IV; MW; 209B. (5) VI; TTh; 102B. (6) VII; TTh; 102B. Mr. Stehman.

156f. Advanced Corporation Finance. Three credits. (1) I; TThS; 209B. (2) II; TThS; 213B.

161f,w. Labor Problems and Trade Unionism. Three credits. Fall. Lect. IV; MW; 202B. (1) IV; F; 202B. (2) IV; F; 209B. (3) I; F; 213B. Winter. III; TThS; 302D. Mr. Hansen.

162w. The Labor Movement in America and England. Three credits. IV; MWF; 202B. Mr. Hansen.

167w. Personnel Administration. Managerial policy, for various types of organization, on labor. Special attention to job analysis. Employment incentives, and regularization of employment. Three credits. II; TThS; 209B. Mr. Hansen.

168s. Advanced Personnel Administration. Special attention to employee-training, joint relations, health and safety, and methods of personnel research, e.g. by analysis of labor turnover. Three credits. II; TThS; 209B. Mr. Hansen.

169s. The Labor and Socialist Movement in Europe. Three credits. IV; MWF; 202B. Mr. Hansen.

176f,s. Commercial Policies. Theory of international commerce; free trade, reciprocity, subsidies, preferential treatment, the open door, international finance, commercial treaties, foreign politics, and other governmental and organized efforts to affect trade. American problems emphasized. Three credits. I; MWF; 202B. Mr. Blakey.

177w. Foreign Trade. Three credits. I; MWF; 202B. Mr. Blakey.

180f-181w-182s. Seminars for Seniors and Graduates. Intensive study of problems in respective fields of specialization. In 1922-23 seminars will be offered in the following:

No.	Title	Hour	Day	Building
A.	Accounting	V½-VI	TTh	301B
B.	Business Finance	VIII	MTW	213B
C.	Marketing	VI-VII	TTh	213B
D.	Labor	Ar	Ar	Ar
E.	Statistics	Ar	Ar	Ar
F.	Marketing of Farm Products	Ar	Ar	Ar
G.	Prices of Farm Products	Ar	Ar	Ar

191f-192w. Public Finance. Six credits. III; MWF; 209B. Mr. Blakey.

193s. State and Local Taxation. Three credits. III; MWF; 209B. Mr. Blakey.

COURSES FOR GRADUATE STUDENTS

203f-204w-205s. Seminar in Economic Theory. Intensive study of a limited field in economic theory. Individual investigation, reports, and group discussion. The topic for 1923-24 will be in the theory of interest. Nine credits. VIII½-IX; TTh; 104B. Mr. Garver.

210f-211w-212s. Seminar in Economic History. (See Department of History.) Mr. Gras.

219f-220w-221s. Seminar in Agricultural Economics. Topics and hours to be arranged. Mr. Black, Mr. Price, Mr. Working.

EDUCATION

Professors Melvin E. Haggerty, Earl Hudelson, Leonard V. Koos, Wilford Stanton Miller, Mervin Gordon Neale, Ashley V. Storm, Fletcher H. Swift; Associate Professor Leo J. Brueckner; Assistant Professors William P. Dyer, Albert M. Field, Ross L. Finney, Frank W. Lathrop, Marvin J. Van Wagenen.

Prerequisites.—For major work, at least 6 quarter credits in psychology and in addition to this a total of not less than 18 quarter credits of undergraduate work in education.

Exemption from the language requirement for the Master's degree may be made in individual cases.

Departmental conferences.—Every alternate Monday all graduate students majoring in education are expected to meet with the departmental staff from 7:30 to 9:00 p.m. for conference regarding subjects of original investigation. This work carries no credit.

NOTE.—Candidates for the University teacher's certificate may offer Course 101, 102, or 103 in place of Education 1.

SUGGESTED COURSES FOR ALL CANDIDATES FOR DEGREES

208f. METHODS OF EDUCATIONAL RESEARCH. Suggested for all candidates for degrees. Two credits. III, IV; S; 113Ed. MR. SWIFT.

EDUCATIONAL ADMINISTRATION

113w-114s. HIGH SCHOOL CURRICULUM. Four credits. II; TTh.

119s. ELEMENTARY SCHOOL CURRICULUM. Prerequisites: Education 1 and 3. Three credits. I; TThS; ar. MR. BRUECKNER.

119Tf-120Tw. ELEMENTARY SCHOOL CURRICULUM. (Same as above for teachers.) Two credits. I, II; S; 113Ed. MR. BRUECKNER.

123s. SUPERVISION OF HIGH SCHOOL INSTRUCTION. A course combining consideration of principles and their application to improving high school instruction in the academic and special subjects. Prerequisites: 10 hours in education. Three credits. VIII; TThF; ar. MR. KOOS.

124f. EDUCATIONAL ADMINISTRATION. The organization and administration of state and city school systems with interpretations. Three credits. IX; MWF; 205Ed. MR. NEALE.

125w-126s. CITY SCHOOL ADMINISTRATION. For superintendents and principals. Prerequisite: Education 124. Six credits. III, IX; MWF; 205Ed. MR. NEALE.

160f-161w-162s. THEORY OF SUPERVISION. Purpose, technique, conditions, and testing of supervision. Prerequisites: Education 11 or equivalent. Six credits. III, IV; S; ar. MR. BRUECKNER.

164w. PROBLEMS OF HIGH SCHOOL ADMINISTRATION. Prerequisites: Education 1 and 3. Three credits. VIII; TThF. MR. KOOS.

167s. JUNIOR HIGH SCHOOL. A study of the special purposes of this institution and the appropriate reorganizations to achieve them; the history of the movement. Prerequisites: Education 1 and 3. Three credits. III; MWF. MR. HUDELSON.

167f-168w. Junior High School. (Same as above.) Prerequisites: Education 1 and 3. Four credits. III, IV; S; 112Ed. Mr. Koos.

173w. City School Finance, Part I. A study of municipal school funds and their expenditure with special reference to their relations to other municipal funds and costs. Three credits. VII; MWF. Mr. Swift.

174w. Public School Finance. A critical study of problems of federal and state aid to public schools. Students are strongly advised to take as preparation or in conjunction with this course Economics 191f-192w Public Finance, and Education 126f-127w Methods of Educational Research. Two credits. II; MWF; 205Ed. Mr. Swift.

175s. City School Finance. Analysis of unit costs on various bases; comparative cost accounting systems, budgets, financial records, and reports. Three credits. VII; MWF; ar.

178f-179w. School Surveys. Literature and methods of school surveys. Six credits. VIII; MWF.

205f-206w-207s. Seminar in Educational Administration. Prerequisites: Education 124, 125-126, 160-161-162. Ar.; 111Ed.

215f-216w-217s. Seminar in Public Education in the United States. The following may be considered typical problems: school support, school supervision, administration units. Prerequisites: Education 1 or 101-102-103 and 3. Six credits. IX, X; W. Mr. Swift.

218f-219w-220s. Seminar in Secondary School Problems. Six credits. IX, X; Th; 111Ed. Mr. Koos.

222-223-224. Research Problems in Secondary Education. 6 credits; open to graduate students. Hours arranged. Mr. Hudelson.

Theory and Practice of Teaching

193f. Foundations of Secondary School Methods. A study of the investigations which form the bases of the technique of high school instruction, and the application of their results to high school subject-matter and to high school classroom procedure. Prerequisite: Education 15. Open to seniors and graduates. Three credits. VIII; MWF. Mr. Hudelson.

195w. Problems of High School English Teaching. An intensive study of various means of adapting subject content to high school pupils; observations; classroom experiments; conferences with classroom teachers; pupil advisory work; submission of proposals of special methods. Prerequisite: Education 15 and 21. Open to seniors and graduates. Three credits. III, IV; S; 112Ed. Mr. Hudelson.

EDUCATIONAL PSYCHOLOGY

106f-107w-108s. ADVANCED EDUCATIONAL PSYCHOLOGY. Advanced work in genetic psychology, origin and nature of human organism, development and control of instincts. Methods of measuring rate of learning; typical learning experiments. Group and individual differences, and their relations to educational practice. Prerequisite: Education 55 or equivalent. Nine credits. III; MWF. MR. VAN WAGENEN.

111s. EDUCATIONAL DIAGNOSIS. The typical educational problems involving the nature and use of educational scales, standard tests, and programs of remedial educational procedure based on the results of the test. Prerequisite: Education 55 or equivalent. Three credits. II; MWF. MR. VAN WAGENEN.

111Tf-112Tw. EDUCATIONAL DIAGNOSIS. (Same as above for teachers.) Four credits. I, II; S. MR. VAN WAGENEN.

126f. STATISTICAL METHODS. This course is ordinarily required of all candidates for advanced degrees. Two credits. IX, X; T. MR. VAN WAGENEN.

127w-128s. ADVANCED STATISTICAL METHODS. Prerequisite: Education 126. Four credits. IX, X; T. MR. VAN WAGENEN.

134f-135w-136s. MENTAL TESTS AND MENTAL DIAGNOSIS. A laboratory course in the study of individual differences by means of mental tests. Methods of treating superior and subnormal children. Prerequisite: Education 55 or equivalent. Six credits. VII, VIII; MW. MR. MILLER.

138w-139s. EXPERIMENTAL EDUCATION. A laboratory course in the use of experimental methods, particularly in the field of the psychology of learning. Prerequisite: Education 55 or equivalent. Four credits. IX, X; MW. (Not offered in 1923-24.)

143-144-145. INDIVIDUAL MENTAL EXAMINATION. For teachers of subnormal children. Demonstration and practice in mental diagnosis. Prerequisite: Education 55 or equivalent. Six credits. I, II; S.

146f-147w-148s. PRACTICE COURSE IN MENTAL EXAMINATION. For teachers of subnormal children. Conducted in co-operation with the public schools. Results studied in relation to medical and school data. Prerequisite: Education 134-135-136. Three credits. Ar.

149f-150w-151s. PSYCHO-EDUCATIONAL CLINIC. Conducted in co-operation with the Department of Sociology and the Medical School clinics in pediatrics and nervous and mental diseases. Students will receive systematic instruction in giving psychological examinations and in scientific interpretation of data. Prerequisite: Education 134-135-136. Three to 9 credits. 11:30-1:30; MWF; Millard Hall.

153f-154w-155s. Research Problems in Educational Psychology. Prerequisites: Advanced courses necessary to pursue problems. Consult instructor. Credits and hours arranged. Mr. Haggerty, Mr. Miller, Mr. Van Wagenen.

184f-185w-186s. Mental Deficiency. Survey of mental deficiency in children and adults. Physical traits including study of brain defects, causes and heredity; psychology of mental deficiency; social problems of feeblemindedness. Subject treated with reference to the training of defectives. Prerequisite: Education 55 or equivalent. Six credits. III, IV; S.

197f-198w-199s. Seminar: Problems of Subnormality. Review of the important literature and original investigation. Two credits. IX, X; F.

201f-202w-203s. Seminar in Educational Psychology. A research course for graduate students. Required of all students writing theses in educational psychology. Six credits. IX-X; M; 203Ed. Mr. Haggerty.

History of Education

101f. Foundations of Modern Education. Emphasizes the more important elements in modern education derived from the Hebrews, Greeks, Romans, Middle Ages, and Renaissance. Prerequisites: psychology, 6 credits and 6 credits in the Department of History. Three credits. VIII; MWF; 205Ed. Mr. Swift.

102w. History of Modern Secondary and Higher Education in Europe and America. Prerequisites: psychology, 6 credits and 6 credits in the Department of History. Three credits. VIII; MWF; 205Ed. Mr. Swift.

103s. History of Modern Elementary Education. Emphasis upon the rise of state systems and upon the history of modern educational reform. Prerequisites: same as for Courses 101 and 102. Three credits. VII; MWF; 205Ed. Mr. Swift.

129w-130s. Educational Classics. Prerequisite: Education 1 or 101-102-103. Six credits. IX; MWF; 205Ed. Mr. Swift, Miss Alexander.

131w-132s. Comparative School Systems. A survey of the existing school systems of France, England, Germany, Denmark, with special reference to educational conditions in the United States. Prerequisite: Education 1 or 101-102-103. Six credits. III; MWF; 102Ed. (Not offered in 1923-24.) Miss Alexander.

187f-188w-189s. Seminar in Educational Sociology. The selection of problems to be determined in part by the student's interest. Prerequisites: Education 1 or 101, 102, 103 and 3. Six credits. I, II; S; ar. Mr. Finney.

211-212-213. Seminar in History of Education. Problems to be selected somewhat upon the basis of students' interest. Prerequisites: Education 101-102-103 or its equivalent and 6 credits in the Department of History. Six credits. IX, X; F. Mr. Swift.

Ind.150f-151w-152s. Seminar in Vocational Education. Survey of studies in the field, individual and group investigation, reports, and criticisms. Required of all students writing theses in this special field. 7:30 p.m.; T; 202Ed. Mr. Prosser.

Ind.172. Administration of Industrial Education—Evening Schools. Development of after training of adults. General vs. unit-course organization. Costs. Prerequisite: Ind.171. Two credits. IX, X; T; 202Ed. Mr. Prosser.

Ind.173. Administration of Industrial Education—Part-Time Classes. A study of the new movement for part-time education. Typical schools, comparative state legislation and plans, Minnesota's problems. Prerequisite: Ind.172. Two credits. IX, X; T; 202Ed. Mr. Prosser.

Home Economics Education

141. Problems in Home Economics Education. Prerequisites: Home Economics 42, Education 55. Three credits. VI; MWF. Miss Clara Brown, Miss McNeal.

Agricultural Education

Prerequisites.—For major or minor work, 18 credits in agricultural education and preparation in agricultural subjects satisfactory to the Department of Agricultural Education.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

131f,w,s. Methods in Teaching High School Agriculture. Prerequisite: Agricultural Education 11. Five credits. III; MTWThF; 317Ad. Mr. Field.

151w,s. Organization and Management. Organization and management of work in secondary schools, particularly of Minnesota, with special reference to agricultural work, courses of study, programs, equipment, laboratory and class management, extension work, plots, and co-ordination of work. Prerequisite: Agricultural Education 11, 21. Five credits. IV; MTWFS; 317Ad. Mr. Storm, Mr. Dyer.

153f,s. Consolidated Rural Schools. To prepare principals to meet the problems peculiar to consolidated rural schools. Prerequisite: Agricultural Education 11. Three credits. I; TThS; 317Ad. Mr. Dyer.

154f,w. Rural Education and Community Life. The rural school as a community center for educational, social, and recreational work. Prerequisite: Agricultural Education 11. Three credits. II; TThS; 317Ad. Mr. Dyer.

155s. Consolidated Rural School Problems. Opportunity for intensive study and research in special problems of administration and supervision of village and consolidated rural schools. Prerequisites: 11, 153, or equivalent. Three credits. Ar. Mr. Dyer.

171su. Problems in Procedure. For agriculture teachers. Emphasizes working out problems in detail in order that the processes as formulated can be used in teaching the following year by those enrolled. Prerequisites: 131, 41, 42. Three credits. Mr. Lathrop.

176s. Advanced Visual Presentation. Based on Course 75. Further work in design and construction of charts and lantern slides. Special study of motion picture machines. Actual practice in effective use of visual aids in lecture and recitation. Prerequisite: 75. Three credits. Ar.

191f-192w-193s. Seminar in Agricultural Education. Individual investigation and research; review and interpretation of current educational literature. Prerequisite: Agricultural Education 11. Two credits each. Mr. Storm, Mr. Field.

COURSES PRIMARILY FOR GRADUATE STUDENTS

201f-202w-203s. Advanced Seminar. Study of the broader administrative problems and policies in the field of agricultural education. Opportunity for independent investigation and research. One to 2 credits per quarter. 209Ad(F). Mr. Storm, Mr. Field.

221f-222w-223s. Graduate Problems. Making investigations, gathering data, and formulating plans regarding agricultural education. Three credits. 209Ad(F). Mr. Storm, Mr. Dyer, Mr. Field.

Agri. Educ.241f. Operation of Vocational Agriculture. Problems involved in the state and local activities in conducting vocational agriculture. It includes a study of federal and state laws and regulations, courses of study, duties of the state supervisor, reports, records, and conferences. Two credits. Mr. Storm, Mr. Field.

Agri. Educ.242w,243s. Organization and Administration of Teacher-Training for Vocational Agriculture. Development of teacher-training institutions, agricultural college curricula, professional needs of high school teachers, professional courses and their content, equipment, itinerant teacher-training, practice teaching, teacher evaluation. Mr. Storm, Mr. Field.

ELECTRICAL ENGINEERING

Professors George D. Shepardson, Frank W. Springer, William T. Ryan; Assistant Professors Cyril M. Jansky, Jr., Edwin R. Martin; Instructor John H. Kuhlmann.

Prerequisites.—For major work, Courses 121 to 126 or their equivalent; for minor work, 6 credits in physics, also integral calculus.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

111f-113w-115s. Electrical Machinery. Prerequisite: one year in college physics, three credits per quarter. 9:30; MWF. Mr. Springer.

112f-114w-116s. Electrical Machinery Laboratory. To be taken with Course 111-113-115. Lectures and practice. Prerequisite: Physics 41-42. Two credits per quarter. Mr. Springer, Mr. Martin.

121f-123w-125s. Alternating Currents. Prerequisite: Electrical Engineering 115. Three credits per quarter. 10:30 or 11:30; MWF. (Two sections.) Mr. Ryan.

122f-124w-126s. Alternating Current Laboratory. To be taken with Course 121-123-125. Prerequisite: Electrical Engineering 116. Two credits per quarter. Mr. Springer.

132f-134w-136s. Electrical Design. Prerequisite: Electrical Engineering 115. To be taken with Course 121-123-125. Two credits per quarter. Mr. Kuhlmann.

141f. Central Stations. Operation, design, and construction of electric power generating stations. Prerequisite: Electrical Engineering 115. Two credits. 10:30; ThS. Mr. Ryan.

142w. Electrical Transmission. Prerequisite: Electrical Engineering 141. Two credits. 10:30; ThS. Mr. Ryan.

144w. Railway Electrical Engineering. Prerequisite: Electrical Engineering 115 or 45. Two credits. 11:30;MW. Mr. Martin.

145s. Steam Railroad Electrification. Prerequisite: Electrical Engineering 144. Two credits. 11:30; MW. Mr. Martin.

151f. Electric Lighting. Lectures, problems, and laboratory practice. Prerequisite: one year in college physics. One credit. Mr. Martin.

152f. Photometric Laboratory. Photometric studies of incandescent and arc electric lamps, gas and oil lamps. Bench and radial photometers and illuminometers. To be taken with Electrical Engineering 151. One credit. Mr. Martin.

161f. Radio Communication. Phase relations in high frequency circuits. Mathematical theory of damped wave transmission and receiving circuits. Inductance and capacity measurements using damped waves. The electron tube as a detector and amplifier. Signal Corps apparatus. Prerequisite: registration in Electrical Engineering 121. Three credits. 8:30; ThS. Laboratory sections. Mr. Jansky.

162w. Radio Communication. Theory and measurement of logarithmic decrement. Undamped wave transmitting and receiving circuits. Heterodyne reception. The arc, high frequency generator, and electron

tube as sources of high frequency power. High frequency measurements, using undamped waves. Prerequisite: Electrical Engineering 161. Three credits. 8:30; ThS. Laboratory sections. Mr. Jansky.

163s. Radio Communication. Mathematical theory of the electron tube and its use in the radio circuit. Design of electron tube oscillator and amplifier circuits. Radio telephony, modulation, carrier frequencies. Direction-finding apparatus and selective circuits for interference elimination. Prerequisite: Electrical Engineering 162. Three credits. 8:30; ThS. Laboratory sections. Mr. Jansky.

164f. Telegraph and Telephone Apparatus. Theoretical and experimental study of apparatus used for signaling, telegraphy, and telephony. Lectures and laboratory. Prerequisite: to be taken with Course 121. Two credits. Mr. Shepardson, Mr. Swenson.

165w-166s. Telegraph and Telephone Circuits. Theoretical and experimental study of telegraph and telephone circuits and the phenomena of long line transmission. Prerequisite: Course 164. Two credits per quarter. Mr. Shepardson.

167f-168w-169s. Radio Station Operation. For men already proficient, licensed radio operators. Open only to a limited number by permission. One credit per quarter. Mr. Jansky.

183f-184w-185s. Electrical Laboratory. Efficiency tests and special problems. Prerequisite: Electrical Engineering 126. Credits as arranged. Mr. Shepardson, Mr. Springer.

186w or s. High Tension-Testing. Low frequency pressure up to 320,000 volts and high frequency to several million volts applied to the study of dielectric phenomena, testing of high tension equipment, etc. Prerequisite: Electrical Engineering 124. Two credits. Mr. Springer.

191f-192w-193s. Journal-Reading. Weekly discussion of current electrical periodicals. Prerequisite: Electrical Engineering 115 or equivalent. No graduate credit. Mr. Shepardson.

COURSES PRIMARILY FOR GRADUATE STUDENTS

221f. Transient Electrical Phenomena. Mathematical study of the electric circuit containing resistance, inductance, and capacity. Abnormal currents and voltage upon switching circuits containing iron core inductances. Prerequisite: Electrical Engineering 121. Two credits. Mr. Jansky.

223w. Transient Electrical Phenomena. Current and voltage distribution in circuits containing distributed resistance, inductance, and capacity. Distortion in telephone lines and its correction. Prerequisites: Electrical Engineering 221. Two credits. Mr. Jansky.

225s. Transient and High Frequency Phenomena. Transient phenomena in coupled circuits. Distribution of current and flux in conductors at high and low frequencies. Change of resistance with frequency. Theoretical study of special problems. Prerequisites: Electrical Engineering 223. Two credits. Mr. Jansky.

232f-234w-236s. Electrical Design. Special problems. Prerequisites: Electrical Engineering, 125, 136. Credits as arranged. Mr. Ryan, Mr. Kuhlmann.

237s. Electric Power Transmission Design. Preparation of detailed plans and specifications for the construction of high voltage transmission lines and distributing systems. Economic, electrical, and mechanical principles and calculations. Mr. Ryan.

251w-253s. Illuminating Engineering. Lectures and laboratory work. Methods of determining location, kind, and quality of lights for obtaining desired illumination. Prerequisite: Electrical Engineering 151. Two credits per quarter. Mr. Shepardson.

281w-282s. Advanced High Frequency Measurements. Vector treatment of circuit networks. Bridge circuits for the measurement of resistance, inductance, and capacity at audio and radio frequencies. Prerequisite: Electrical Engineering 126. Two credits per quarter. Mr. Jansky.

284f-285w-286s. Precise Electrical Engineering Measurements. Lectures and laboratory work. Open to a limited number subject to approval. Prerequisites: Electrical Engineering 123, 124. One or two credits. Mr. Springer.

275f-276w-277s. Electrical Engineering Research. Investigation of special problems in laboratory or library. Prerequisite: Electrical Engineering 126. Two to four credits per quarter. Mr. Shepardson, Mr. Springer, Mr. Ryan, Mr. Martin, Mr. Jansky, Mr. Kuhlmann.

291f-292w-293s. Graduate Seminar. Discussions of problems and results of research work. One credit per quarter. Mr. Shepardson, Mr. Jansky.

294f-295w-296s. Electrical Ignition and Automobile Electrical Accessories. The study of ignition apparatus; characteristics of automobile accessories, such as generators, starters, controllers, etc. Laboratory and lectures. Prerequisite: Electrical Engineering 121 or equivalent. Two credits per quarter. Mr. Springer.

G.E.111s. Valuation of Public Utility Properties. Factors affecting value, depreciation, taxation, and regulation of public utility properties. Elements of engineering economics; cost analysis, economic investigations, rate-making. Open only to seniors and graduates. One credit. Mr. Ryan and nonresident lecturers.

G.E.124w. Engineering Relations. Lectures, assigned reading, and discussions on the human side of engineering. Relations of the engineer to employer, employees, customers, and public. Engineering code of ethics. Bridging between college and business. Practical training of engineering graduates. Open only to seniors and graduates. Mr. Shepardson and nonresident lecturers.

ENGLISH

Professors Joseph M. Thomas, Richard Burton,[1] Frederick Klaeber (Comparative Philology), Elmer E. Stoll; Associate Professors Joseph W. Beach,[2] Cecil A. Moore; Assistant Professors Kemp Malone, Laurence Mason, Charles W. Nichols, Martin B. Ruud, Thomas M. Raysor, Hazelton Spencer, Emerson G. Sutcliffe.

Before registering for graduate courses, students should consult with the director of graduate work for the department, Professor Stoll.

Before the acceptance of the subject for a thesis candidates for the M.A. or the Ph.D. degree must have given evidence to the department that they speak and write English with propriety.

REQUIREMENT FOR MASTER OF ARTS DEGREE

1. *Prerequisite.*—For major work, not less than 27 credit hours in the subject, including satisfactory introductory courses in Old English and either Chaucer or Shakespeare.

If English is offered as a minor, not less than 27 credit hours in the subject.

2. A candidate is not permitted to count toward the degree more than one course running through the year (or its equivalent) the primary purpose of which is practice in writing.

REQUIREMENTS FOR DOCTOR OF PHILOSOPHY DEGREE

1. *Delimitation of the field.*—The general field of English is divided into two periods (1) Early English and (2) Modern English. The boundary line between these periods may be drawn anywhere between 1500 and 1550 according to the requirements of the candidate's program. A candidate may select as his major subject either the Early English or the Modern English period.

2. The candidate will be examined as to his knowledge of the whole field of English literature, but much more thoroly in that portion of the field covered by his major. Special emphasis will be laid, in the final examination, on one particular period or one particular type (such as drama, lyric, or essay) with which he is presumed to be especially familiar. This particular period or type would naturally be that connected with his thesis.

[1] Absent on leave, fall and winter quarters.
[2] Absent on leave, 1923-24.

3. The candidate must have completed, before examination, advanced courses in Chaucer and Shakespeare.

4. A good reading knowledge of Latin is in all cases desirable, and in some cases may be indicated by the candidate's adviser as indispensable.

COURSES IN ENGLISH

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

101f. Introduction to Middle English. An outline of Middle English grammar, including the interpretation of selected texts. Prerequisites: English 6 and 50. Two credits. VI; TTh; 205F. Mr. Klaeber.

103s. Beowulf. An introduction to the Old English poem, with reading of considerable portions of the text. Prerequisites: either Course 6 or 8 and 50. Three credits. VI; MWF; 205F. Mr. Klaeber.

105w-106s.† Eighteenth-Century Poetry. From Pope to Burns, with special reference to the rise and growth of naturalism and romanticism. Prerequisites: Courses 6 and 8 or either 6 or 8 and one other course numbered above 5. Six credits. VII; MWF; 205F. Mr. Mason.

107w-108s.† Eighteenth-Century Prose. Special study of fiction and the essay. Prerequisites: Courses 6 and 8 or either 6 or 8 and one other course numbered above 5. Six credits. VII; MWF; 204F. (Not given in 1923-24.) Mr. Moore.

109f-110w.† The Romantic Poets of the Nineteenth Century. From Wordsworth to Keats. Prerequisites: Courses 6 and 8 or either 6 or 8 and one other course numbered above 5. Six credits. III; TThS; 204F. Mr. Raysor.

123f-124w-125s. Studies in Victorian Novelists. George Meredith; or, in alternate years, Thomas Hardy and Henry James. Hardy and James in 1922-23. Prerequisites: Courses 6 and 8 or either 6 or 8 and one other course numbered above 5. Nine credits. 4 to 6 o'clock; T; 205F. (Not given in 1923-24.) Mr. Beach.

129s. Modern Drama. Contemporary drama from 1870 to the present. Prerequisites: Course 8 and one other course numbered above 5. Four credits. II; MWThF; 301F. Mr. Burton.

133f. Ballads. Prerequisites: Courses 6 and 8, or either 6 or 8 and one other course numbered above 5. Three credits. III; MWF; 204F. Mr. Ruud.

136s. Advanced Shakespeare. Shakespeare's development traced to the end. A careful analysis of four plays. Problems in the interpretation of Shakespeare's dramatic methods. Prerequisites: Course 8 and one other course numbered above 5. Open without further prerequisites to students receiving B in Course 8. Four credits. I; TThFS; 205F. Mr. Stoll.

140s. Advanced Chaucer. The more important of Chaucer's poems aside from *The Canterbury Tales;* the source and chronology of Chaucer's work. Prerequisites: Course 6 and one other course numbered above 5. Open without further prerequisites to students receiving B in Course 6. Four credits. II; TWThS; 205F. Mr. Malone.

141f-142w-143s.† Historical Grammar of the English Language. This course is identical with Comparative Philology 141-142-143. Prerequisites: Courses 6 and 8, or either 6 or 8 and one other course numbered above 5. Six credits. Mr. Klaeber.

146f-147w.† The Metrical Romances. The more important Middle English romances; an introduction to the great stories of love and chivalry current in the Middle Ages, particularly those connected with Arthur and the Round Table. Prerequisites: Course 6 and one other course numbered above 5. Six credits. VII; MWF; 205F. (Not given in 1923-24.) Mr. Malone.

148f-149w.† Arthurian Romances. Prerequisites: Course 6 and one other course numbered above 5. Six credits. VIII; MWF; 205F. Mr. Malone.

150f. Victorian Poetry. The poetry of the Victorian era, aside from Browning's and Tennyson's. The principal names are: Matthew Arnold, the Rossettis, Fitzgerald, Morris, Swinburne, and Meredith. Prerequisites: Courses 6 and 8, or either 6 or 8 and one other course numbered above 5. Four credits. VII; MTWF; 205F. Mr. Stoll.

151. Recent Poetry. Poetry in England and America since the death of Queen Victoria. The main tradition and tendencies now prevailing. Prerequisites: Courses 6 and 8, or either 6 or 8 and one other course numbered above 5. Four credits. (Not given in 1923-24.) Mr. Beach.

152w. Pre-Elizabethan Drama. Prerequisites: Course 8 and one other course numbered above 5. Four credits. III; TThFS; 205F. Mr. Malone.

155s. The American Novel. The history of the American novel from the beginning to the present. Prerequisites: Course 6 or 8 and 44-45. Four credits. (Not given in 1923-24.) Mr. Moore.

COURSES PRIMARILY FOR GRADUATE STUDENTS

201f. Old English. Comparative study of Anglo-Saxon (Old English) grammar and reading of prose texts. Once a week, two hours. Three credits. Mr. Klaeber.

202w-203s. Old English Poetry. Critical reading of poems. Once a week, two hours. Six credits. Mr. Klaeber.

208. Piers the Plowman. A study of critical problems relating to the text and authorship. Three credits.

209f-210w-211s. The Middle English Lyric. (Not given in 1923-24.)

213f-214w-215s. Seminary in Eighteenth-Century Drama. Special attention will be given to the rise and progress of sentimental comedy and domestic tragedy. Nine credits. (Not given in 1923-24.) Mr. Moore.

218. Seminary in the Restoration Drama. The drama from the Restoration to the rise of sentimental comedy. Special attention given to the comedy of manners (from Etherege to Farquhar) and its relation to the life of the time. Nine credits. (Not given in 1923-24.) Mr. Stoll.

220f-221w-222s. Seminary in Medieval Drama. Nine credits. 4 to 6 p.m.; W; 302F. Mr. Ruud.

225-226-227. Seminary in Elizabethan Drama. Elizabethan and Jacobean dramatists, from Lyly to Shirley. Problems assigned may involve Shakespeare, and in general his contemporaries will be studied less for their own sakes than for the light they shed upon him. Nine credits. (Not given in 1923-24.) Mr. Stoll.

228-229-230. Seminary in Eighteenth-Century Novel. The rise and development of the novel as a form of literature; the use made of the novel as a medium for religious, social, and political theory. Nine credits. (Not given in 1923-24.) Mr. Moore.

231f-232w-233s. Shakespeare's Tragic and Comic Art. Nine credits. 4 to 6 p.m.; M; 302F.

234f-235w-236s. Seminary in Middle English Literature. In 1924-25 the literary monuments will be studied with reference to the mythological and foklore material which they contain. Nine credits. (Not given in 1923-24.) Mr. Malone.

For courses in Comparative Literature see page 44.

COURSES IN RHETORIC

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

100w-101s.† Versification. The nature of poetry and a detailed analysis of English meters and the various English verse forms. The theory accompanied by criticism of current poetry and practice in writing verse. Open to those who have taken Course 11-12-13 or 15-16-17, and who have taken or are taking nine hours in the historical study of English poetry. Six credits. (Not given in 1923-24.) Mr. Nichols.

111w-112s. Essay-Writing. Practice in writing didactic, biographical, critical, informal essays. Extended composition. Individual aid in gathering of material, planning of papers, and criticism of essays. Analysis of a considerable body of modern essays. Prerequisites: Rhetoric 15-16, or 18-19, or 47-48. Six credits. III; MWF; 304F. Mr. Sutcliffe.

115f-116w-117s. Dramatic Technique. Principles of plotting, characterization, climax, dialog, and scenario-making. Writing of three plays—two original, one dramatized short story. Required readings, laboratory work, criticisms of local productions. Open to those who have taken Course 11-12-13 and have taken or are taking English 129. Nine credits. (Not given in 1923-24.) 304F.

119f-120w-121s. Seminary in Writing. Open to advanced students who write with facility and who desire personal direction. Criticism of manuscripts submitted. Open with special permission to seniors and graduates who have completed Course 18-19 or 47-48, and nine additional credits in rhetoric. Nine credits. VI, VII; Th; 304F. Mr. Thomas.

COURSES PRIMARILY FOR GRADUATE STUDENTS

201f-202w-203s. Seminary in Rhetoric. (Graduate seminary but open to seniors taking the Honors Course.) For those who are specializing in rhetoric and composition. Prerequisites: Course 18-19 or 47-48 and 9 additional credits in rhetoric. Nine credits. Mr. Thomas.

ENTOMOLOGY AND ECONOMIC ZOOLOGY

Professors William A. Riley, Arthur G. Ruggles, Frederic L. Washburn; Associate Professor Royal N. Chapman; Assistant Professors Harry H. Knight, Oscar W. Oestlund.

Prerequisites.—Eighteen credits in animal biology and entomology.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

117f-118w-119s. General Ecology of Insects. General ecology with special reference to the insects of Minnesota. Frequent field trips. Lectures, laboratory, and field work. V-VII; TTh; 208-210AB. Mr. Chapman.

124su. Advanced Entomology. Similar to 117-118-119 with special field work. Mr. Chapman.

125f-126w-127s. Advanced General Entomology. Morphology and classification of insects with lectures on the history of entomology. Lectures and laboratory. III, IV; TThS; 208-210AB. Mr. Oestlund.

130w. Biology and Taxonomy of the Aphididae. Intensive study of the natural history, bibliography, and classification of the Aphididae. Additional work is offered under Course 175. III, IV; MWF; 208-210AB. Mr. Oestlund.

139-140. History and Development of Insects. Lectures and laboratory work on the histology, embryonic and postembryonic development of insects. Individual work along these lines is available to properly qualified students under Course 197. II-IV; TTh, and ar.; 321 Adm. (F). Mr. Riley.

144f-145w-146s. Animal Parasites and Parasitism. Lectures and laboratory work. Second term devoted primarily to the relation of insects to diseases of man and animals. V-VII; WF; 208-210AB. Mr. Riley.

150su. Insecticides and Their Action. Ar; Insectary (F).

197f,w,s,su. Introduction to Research. Preparation for investigational work in lines of entomology, parasitology, or economic zoology. Summer work should be planned when possible. Mr. Riley, parasitology, insect morphology; Mr. Ruggles, general economic entomology; Mr. Washburn; economic vertebrate zoology, insecticides; Mr. Knight, Mr. Oestlund, systematic entomology.

COURSES PRIMARILY FOR GRADUATE STUDENTS

201-204. Research in Entomology. Mr. Riley, Mr. Chapman, Mr. Knight, Mr. Oestlund.

205-208. Research in Economic Entomology. Mr. Ruggles, Mr. Graham.

209-212. Research in Economic Vertebrate Zoology. Mr. Washburn.

261-264. Research in Parasitology and Medical Entomology. Mr. Riley.

265-268. Research in Insecticides.

EXPERIMENTAL ENGINEERING

Professors Frank B. Rowley, William E. Brooke, John J. Flather, William F. Holman; Associate Professors Jacob O. Jones, John H. Rowen, Charles F. Shoop; Assistant Professors Maurice B. Lagaard, Fred C. Lang, George A. Maney, George C. Priester, Burton J. Robertson.

Note.—Experimental work relating to various branches of engineering may be carried on in the Experimental Engineering laboratories. The following courses are offered by the departments indicated. Work of a special character, such as advanced research, may be arranged through consultation with the director, Professor Rowley.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

M. M. 141f,w,s. Materials-Testing Laboratory. Investigation of the physical properties of various metals and engineering materials. One credit. Mr. Brooke, Mr. Holman, Mr. Priester.

M. M. 143f,w,s. Hydraulic Laboratory. Experimental and demonstrational work. One credit. Mr. Jones, Mr. Boehnlein.

M. M. 192w. Hydraulic Motors Laboratory. An experimental study of the characteristics of the hydraulic ram, centrifugal pump, reaction turbine, and impulse wheel. Three credits. Mr. Jones.

M. M. 193s. Hydraulic Measurements. A detailed study of the current meter, Venturi meter, weir, orifice, traveling screen, chemical method of gaging, etc. Three credits. Mr. Jones.

M. E. 181w. Advanced General Laboratory. Indicator practice, valve-setting, separating and throttling calorimeters, tests of steam engines, gas engines, pumps, air compressors, blowers, turbines, boilers, and power plant. Four actual hours. Mr. Rowley, Mr. Shoop.

M. E. 182f. Advanced Steam Laboratory. Tests of steam turbines, flow of steam through nozzles and pipes. Tests of compounds and triple expansion engines, condensers, superheaters, and boilers. Two credits. Mr. Shoop.

M. E. 183w. Power and Gas Engine Laboratory. Tests of gas, gasoline, and hot air engines, gas producers. Power and lighting plants. Two credits. Mr. Rowley, Mr. Robertson.

M. E. 184s. Advanced Engineering Laboratory. Opportunity will be offered for carrying on investigations in connection with tests of complete power plants, refrigerators, air compressors, blowers, and fans. Also automobile testing and gas engine investigations. Two credits. Mr. Rowley, Mr. Shoop, Mr. Robertson.

COURSES PRIMARILY FOR GRADUATE STUDENTS

C. E. 237w-238s. Structural Laboratory. Similar to Course 243, but dealing mainly with experimental problems in structural steel. Mr. Lagaard, Mr. Maney.

C. E. 243w-244s. Cement and Concrete Laboratory. Laboratory technique and experimental investigation of special problems in cement, concrete, and reinforced concrete. Mr. Lagaard.

C. E. 251. Highway Laboratory. Investigations in co-operation with State Highway Department. Mr. Lang.

C. E. 263. Hydraulic Laboratory. Study of special hydraulic problems in laboratory, drafting room, and field.

M. E. 287-288-289. Research in Mechanical Engineering. Courses may be elected which involve investigations in connection with steam and gas engines, heating, and ventilating. Reports, special problems, and related tests. Three to 9 credits. Mr. Rowley, Mr. Flather, Mr. Rowen, Mr. Shoop.

FORESTRY

Professors Edward G. Cheyney, John H. Allison; Associate Professor John P. Wentling.

Prerequisites.—For major work, 27 credits in forestry, three quarters of botany or equivalent. For minor work, 9 credits in the department.

Exemptions from the language requirement for the Master's degree may be made in individual cases.

The choice in subject must be made by the candidate and approved by the chief of the division and instructor. The facilities of the forest experiment stations at Cloquet and Itasca are available to students taking this work.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

101w. Advanced Dendrology. A continuation of Course 3-4 with special studies in classification and distribution of the timber species of the world. Prerequisites: 10 credits in botany and 8 credits in dendrology. Three credits. W; ar. Mr. Wentling.

106w. Investigative Methods in Forestry. The fundamental principles upon which sylviculture is based, methods used at experiment stations in solving problems in forestation, protection, and management. Prerequisites: 9 credits in sylviculture. Three credits. I; MWF.

107f. Uses of Wood I. The economic hard and soft woods, both foreign and domestic from standpoint of regions of production, distribution centers, qualities, amounts, and prices in relation to the wood-using industries. Lectures, reading, reports. Prerequisite: 33-34. Three credits. IV; MWF; 303Hr.

108w. Uses of Wood II. A continuation of Course 107 dealing with the industries and the woods they use. Kinds, grades, qualities, properties, requirements for each product. Use, re-use, distribution of product. Regions of production and relation to other industries. Lectures, reading, reports. Prerequisite: 33-34. Three credits. IV; MWF; 303Hr. Mr. Wentling.

109s. Uses of Wood III. The actual use of wood in the industries. At least six hours per week must be spent in actual study in a factory. Complete reports and collateral reading. Prerequisite: 107-108. Three credits. VI, VII, VIII, IX; WF. Mr. Wentling.

110f-111w. Mechanical and Physical Properties of Wood. Study of strength as related to density, quality, etc. Wood stresses, failures, and methods of testing timbers. 6 credits. Prerequisites: 33-34. WF. Mr. Wentling.

112. Advanced Forest Mensuration. Continuation of Course 10 with special emphasis on tree forms, the development of the formula used in study of volume and growth of trees. Mr. Hansen.

113w. Advanced Forest By-Products. A detailed study of production of wood pulp and paper products, naval stores, tannins, oils, wood distillation products, etc. Lectures, reading, reports. Prerequisites: 33-34, Chem. 3 or 10 and Chem. 36. Ar. 302Hr.

119f. Advanced Wood Structure I. A detailed study of the elements and structure of native and foreign economic woods. Preparation, sectioning, and mounting of typical sections. Reference reading and reports. Six hours per week. Prerequisites: Courses 33-34. Three credits. Mr. Wentling.

120w. Advanced Wood Structure II. Study of wood structure in relation to seasoning, mechanical failures, penetration or preservatives, variation in strength, etc. Six hours per week. Prerequisite: Course 119. Three credits. Mr. Wentling.

COURSES PRIMARILY FOR GRADUATE STUDENTS

201-202. Research Problems in Science and Practice of Sylviculture. Mr. Wentling.

203-204. Research Problems in Management and Working Plans. Mr. Allison.

205-206. Lumber Markets and Prices. Mr. Cheyney.

207f-208w-209s. Research in Wood Technology. Mr. Wentling.

GEOLOGY AND MINERALOGY

Professors William H. Emmons, Frank F. Grout, Clinton R. Stauffer; Assistant Professors John W. Gruner, George M. Schwartz; Instructor George A. Thiel.

Prerequisites.—For major work in:

General geology and economic geology, Courses 1, 9 or 10, 21, 22; a knowledge of general chemistry. Course 105 must be carried along with other graduate work.

Petrology, Courses 1, 3, 21, 22, elementary chemistry and physics.

Paleontology, Courses 1, 11, or 91-92-93. Animal biology is a desirable antecedent.

Exemptions from the language requirements for the Master's degree may be made in individual cases. Students who are deficient in modern languages are advised to take a language along with their graduate work. Examinations in French and German are required of candidates for service on the United States Geological Survey.

COURSES

101f. Principles of Stratigraphy. Origin and structure of sedimentary deposits; the interpretation of these in relation to paleogeography; field work in connection with Cambrian and Ordovician problems. Three credits. Mr. Allison.

105f. Elements of Rock Study. Prerequisite: Course 22 or 25. Three credits. VI, VII; TTh; 110P. Mr. Grout.

106w. Petrography. The identification and study of minerals and rocks by topical methods; the study of igneous rocks, crystalline schists, and metamorphic rocks. The origin and classification of rocks. Prerequisite: Course 105. Three credits. VI, VII; TTh; 110P. Mr. Grout.

107f-108w-109s. Paleontologic Practice. The collection, preparation, and study of materials, with a view to gaining a working knowledge of groups of fossils, and the use of literature. Prerequisite: Course 59. Nine credits. V, VII; MWF; 105P. Mr. Stauffer.

111f. Ore Deposits. The nature, distribution, and genesis of ore deposits of the United States; relations of ore deposits to geologic structure; the deformation and superficial alteration of ore deposits. Prerequisites: Courses 10, 105. Three credits. I; TThS; 110P. Mr. Emmons.

112w. Geology of Petroleum. First part treats deposits of metals, giving special attention to those outside of the United States. Second half treats the nature, origin, and distribution of petroleum and discusses the various oil fields of the world. Prerequisite: Course 111. Three credits. I; TThS; 110P. Mr. Emmons.

113s. Problems in Ore Deposits. Field excursions, map work, lectures on field and laboratory methods. Prerequisite: Course 112. Three credits. V, VIII; Th; 110P. Mr. Emmons.

124w-125s. Structural and Metamorphic Geology. The conditions, processes, and results of metamorphism; structural features resulting from deformation under varying conditions of load. Prerequisites: Courses 9 or 10, 105. Six credits. VI; MWF; 200aP. Mr. Schwartz.

127. Geology of the Lake Superior Region. Structure and correlation of districts. Interpretation of field notes and survey reports. Practical problems. The use of geologic bibliographies and literature. Prerequisites: 124-125. Mr. Thiel.

131f-132w-133s. Advanced Petrology. Advanced optical methods. Regional and genetic studies. Petrographic reports. Prerequisite: Course 106. Nine credits. Hours to be arranged. 200P. Mr. Grout.

137w. Testing Economic Minerals. Laboratory tests of coal, clay, oil, building stone, and metallic ores. Prerequisites: Courses 1, 105. Three credits. T; 200P. Mr. Grout.

140w-141s. Applied Petrography. Determination of ore and gangue minerals, microscopic studies of paragenesis of ores and other mineral associations. Practical problems in mining and geology, settled by microscopic and optical examination. Prerequisite: Course 131. Six credits. Hours to be arranged. 200P. Mr. Grout, Mr. Gruner.

144w-145s. Construction and Interpretation of Geologic Maps. Methods of geological examination; study and problems in construction and interpretation of geological maps. Prerequisite: Courses 9 or 10. Six credits. Hours to be arranged. 104P. Mr. Allison.

150s. Field Geology. Detailed, systematic work, conforming to official surveys. Reports to be written week before college opens. For prerequisites see members of the department. Credits arranged. Mr. Emmons, Mr. Schwartz.

151f-152w-153s. Advanced General Geology. Geologic processes and their results; development of the North American continent. Prerequisite: Course 9. Nine credits. III; MWF; 104P. Mr. Stauffer.

166f-167w. Mineralography. Methods of studying opaque minerals and application of the methods to problems in ore genesis and history. Prerequisite: Course 111. Six credits. Hours to be arranged. 103P. Mr. Schwartz.

COURSES PRIMARILY FOR GRADUATE STUDENTS

211f-212w-213s. Advanced Paleontology. Selected groups of fossils. Class work supplemented by reference reading and thesis. Three credits. Mr. Stauffer.

214. Seminar in Ore Deposits. Three credits. Mr. Emmons.

215s. Geology and Ore Deposits of the Western Hemisphere. Open to graduate students and to those undergraduates who have had Course 111. Offered in spring quarter, 1924. Three credits. Mr. Emmons.

216s. Geology and Ore Deposits of the Eastern Hemisphere. Prerequisites same as for Course 215. Offered in spring quarter 1925. Three credits. Mr. Emmons.

220. Glacial Geology. Hours to be arranged. The drift sheets, glacial lakes, the gorge of St. Anthony Falls, the dalles of the St. Croix, and other problems. Lectures, reference reading, and field work.

241. Field Course in Geology. To be arranged with individual students upon application to the department. Credit will be given for field work done satisfactorily as prescribed in the joint announcement of various universities.

243-244. Research Course in Geology. Advanced work in general geology; chiefly individual work on selected subjects. Data and collections of material gathered in the course of field work studied under instructor. Methods follow standards of federal and state surveys. Mr. Emmons, Mr. Grout, Mr. Stauffer.

246. Pre-Cambrian Geology. The problems of pre-Cambrian correlation and structure; the pre-Cambrian stratigraphy of North America. Given in alternate years. Three credits.

251-252. Original Problems. Morphology and physical measurements of minerals. Three credits each. Mr. Gruner.

253-254. Research Course in Ore Deposits. Methods of Course 243-244 applied to ore deposits. Three credits each. Mr. Emmons, Mr. Grout, Mr. Gruner, Mr. Schwartz.

263-264. Research Course in Petrology. Methods of Course 243-244 applied to petrology. Three credits each. Mr. Emmons, Mr. Grout.

GERMAN

Professor Carl Schlenker; Associate Professors Oscar C. Burkhard, Samuel Kroesch; Assistant Professor James Davies.

Prerequisites.—For major work, 27 Senior College quarter credits or equivalent. For minor work, 18 Senior College credits or equivalent. For courses in Germanic Philology see the statement of the Department of Comparative Philology.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

100f-101w-102s. Middle High German. Phonology, morphology, and syntax. Nine credits. VI; MWF; ar. Mr. Kroesch.

107f. Historical German Grammar. Phonology, inflection, word formation, syntax. Intended primarily for prospective teachers of German. Three credits. Mr. Kroesch.

108w. Comparative Phonetics. A study of speech sounds and the nature of their production, with special reference to English, French, and German. Open to students in the modern languages. Three credits. Mr. Kroesch.

109f-110w-111s. History of the German Language. Lectures, discussions, assigned readings. This course is identical with Comparative Philology 109-110-111. Nine credits. Mr. Klaeber.

150f-151w-152s. Die Novelle. A study of the technique and development. Assigned readings and reports. Nine credits. (Not offered in 1923-24.) Mr. Burkhard.

153f-154w-155s. Aspects of German Literature of the Nineteenth Century. The subject of the course will be announced from year to year. Subject for 1923-24, *Realism*. Nine credits. VI, VII, VIII; Th; 208F. Mr. Burkhard.

160f-161w-162s. Lyric Poetry of the Eighteenth and Nineteenth Centuries. Nine credits. VI, VII, VIII; M; 209F. Mr. Davies.

COURSES PRIMARILY FOR GRADUATE STUDENTS

225f-226w-227s. Literary Problems. Subject for 1923-24: The Classic Period. Nine credits. VI, VII, VIII; W; 208F. Mr. Schlenker.

GREEK

Professor Charles Albert Savage.

Prerequisites.—For major work, Courses 105, 106 or 107, 108, or their equivalent. For minor work, Courses 51 (Philosophy), 52 (Oratory), 53 (Dramatic Poetry), or their equivalent.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

105f. Lyric Poetry. Selections from the elegiac, iambic, lyric, and bucolic poets. Three times a week. Prerequisites: Greek 51 and 53, or 52 and 53. Three credits. Ar. 112F. Mr. Savage.

106w. Advanced Drama. Aeschylus, Sophocles, or Aristophanes. Special attention given to the development of the drama, and to the literary form of dramatic representation of the plays read. Three times a week. Prerequisite: Greek 53 or 105 or equivalent. Three credits. Ar. 112F. Mr. Savage.

107w. Advanced Prose. Selections from the Greek historians, or from Plato, or from the orators. Alternates with Course 106. Equivalent prerequisites. Ar. 112F. Mr. Savage.

108s. Advanced Epic Poetry. A course of rapid reading in the *Iliad* or the *Odyssey*. Three times a week. Prerequisite: Greek 105 or 106. Three credits. Ar. 112F. Mr. Savage.

COURSES PRIMARILY FOR GRADUATE STUDENTS

201-202-203. Oratory (advanced). A study of the development of oratorical style among the Greeks; selected readings. Twice weekly, one, two, or three quarters. Mr. Savage.

204-205-206. Dramatic Poetry (advanced). The reading and critical study of representative Greek plays. Twice weekly, one, two, or three quarters. Alternates with 201-202-203. Mr. Savage.

207-208-209. Seminar in Philosophy or Oratory. Once a week, one, two, or three quarters. Mr. Savage.

210-211-212. History (advanced). Selected readings from Greek historians. Once a week, one, two, or three quarters. Alternates with 207-208-209. Mr. Savage.

HISTORY

Professors Guy Stanton Ford, Solon J. Buck, William Stearns Davis, Norman Scott Brien Gras, Albert Beebe White; Associate Professors August Charles Krey, Lester Burrell Shippee; Assistant Professor George M. Stephenson; Professorial Lecturer Samuel B. Harding; Instructor Lawrence Steefel.

Prerequisites.—Of the four fields in which general survey courses in history are usually given, namely, ancient, American, English, and European, students entering upon graduate work in history will usually be expected to have covered two or three courses, with credit not exceeding 18 hours. For the other 9 hours, they should have a more advanced course in one of these fields and a second course in some field of history in which intensive work is done with the beginnings of investigation. In meeting these requirements consideration will be given to work done from the historical point of view in others of the social sciences, especially political science. The department attaches considerable importance to adequate preparation in the foreign languages, which may be used by the student in the course of advanced and research work. An especially good equipment here will be taken into consideration in weighing the student's preparation for graduate work.

American History

112s. History of American Immigration. Settlement and development of typical racial stocks in America. Contributions of European immigrants to American life. Attention to political history. Prerequisites: 20 credits in social science group. Four credits. VI; MWThF; 111Lib. Mr. Stephenson.

125w. (Pol. Sci.) American Diplomatic History. Prerequisites: 20 credits in social science group, including 10 credits in political science or History 5-6. Three credits. III; MWF; 102MA.

127s. (Pol. Sci.) American Foreign Relations. Such topics as the Monroe Doctrine, freedom of the seas, the open door, arbitration, disarmament, will be considered with particular reference to the future policy of the United States. Prerequisites: 20 credits in social science group, including 10 credits in political science or History 5-6. Three credits. III; MWF; 102MA.

141f. The West in American History to 1815. Prerequisites: 20 credits in social science group, including History 5-6. Three credits. VIII; MWF; 112Lib. Mr. Buck.

142w. The West in American History, 1815-65. This course, while offered separately, follows, and is calculated to form a natural sequence to History 141. Prerequisites: 20 credits in social science including History 5-6. Three credits. VIII; MWF; 112Lib. Mr. Shippee.

144-145.† History of Minnesota. The settlement and development—political, economic, and social—of a typical American commonwealth. Prerequisites: 15 credits in social science including History 5-6. Six credits. (Not offered in 1923-24.) Mr. Buck.

146w-147s.† Constitutional History of the United States. The evolution of American constitutional government through legislation, judicial interpretation, administrative rule, and custom. Prerequisites: 15 credits in history or 10 credits in history and 10 in social science including 5 credits in political science. Six credits. IV; MWF; 112Lib. Mr. Shippee.

153s. The West in American Politics since 1865. An intensive study of independent parties and radical or progressive political movements. Prerequisites: 25 credits in history including History 5-6. Five credits. VII, VIII; WF; 218aLib. Mr. Buck.

154. Selected Topics in the History of Minnesota. Students taking this course are expected to do a portion of their work in the library of the Minnesota Historical Society. Prerequisites: 25 credits in history including History 5-6. Five credits. (Not offered in 1923-24.) Mr. Buck.

155f. United States, 1850-1865. Consideration is given to social and economic questions as well as political issues. Prerequisites: 25 credits in history including History 5-6. Five credits. VII, VIII; MW; 218aLib. Mr. Shippee.

156. The Reconstruction Period. This course follows History 155 as a natural sequence. Prerequisites: 25 credits in history, including History 5-6. Five credits. (Not offered in 1923-24.) Mr. Shippee.

166f. Selected Topics in the History of Immigration. Competent students will be guided in research. Prerequisites: 25 credits in social science and consent of instructor. Five credits. VII, VIII; TTh; Ar. Mr. Stephenson.

208f-209w-210s. Seminar in American History. Graduate students only. Ar. Mr. Buck, Mr. Shippee, Mr. Stephenson.

See also History 113-114-115† under Economic History; History 121-122† under English History, and History 111 under European History.

Ancient History

103f. The Near East, Old Orient. Origin of Egyptians, Babylonians, Assyrians, and Persians, and main features of their political history and civilization. History of the Hebrews discussed so far as it bears upon general oriental problems. Prerequisites: 20 credits in social science group. Five credits. VIII; MWF; 111Lib. Mr. Davis.

105w. History of Rome. Prerequisites: 20 credits in social science group. Five credits. III; MTThFS; 111Lib. Mr. Davis.

133f. Political History of Greece. With special reference to the reaction upon cultural progress. Prerequisites: 20 credits in history or a major in Greek or Latin. Five credits. III; MTThFS; 111Lib. Mr. Davis.

134w. Ancient Civilization, Greece. Social and intellectual life of Greece. Prerequisites: 20 credits in history, or a major in Greek or Latin. Three credits. VII; MWF; 111Lib. Mr. Davis.

135s. Ancient Civilization, Rome.* Social and intellectual life of Rome. The course will begin with a survey of political history. Prerequisites: 20 credits in history, or a major in Greek or Latin. Three credits. VIII; MWF; 111Lib. Mr. Davis.

Economic History

113-114-115.† Economic History of Europe and the United States, 1750 to the Present. The industrial revolution and significant results for transportation, agriculture, tariff, and labor. Prerequisites: 20 credits in history or economics, or both. Nine credits. (Not offered in 1923-24.) Mr. Gras.

116f-117w-118s.† Economic History of Europe, 1300-1750. Prerequisites: 20 credits in history or economics, or history and economics combined. Nine credits. II; TThS; 111Lib. Mr. Gras.

169s. Economic History of the United States since the Civil War or Some Other Specified Period. Prerequisites: 25 credits in history or economics, or history and economics combined. Five credits. (Not offered in 1923-24.) Mr. Gras.

205-206-207. Seminar in Economic History. Ar. Mr. Gras.

English History

109s. English History, 1815-1920. Emphasis placed upon party history, the colonies, foreign relations, the social democratic movement, and especially British foreign policy preceding the World War. Prerequisites: 20 credits in social science group. Six credits. IV; MTWFS; 125F. Mr. Harding.

* Permission of instructor necessary if student has not taken 134.

121w-122s.† English Backgrounds and the American Colonies. Studies in the transfer of English civilization, and its early modifications and development in America. Some account taken of the contrasting French settlements. Prerequisites: 20 credits in history or political science. Six credits. II; TThS; 112Lib. Mr. White.

162f. The Beginnings of Parliament. From the Norman Conquest to the reign of Edward I, based wholly on original sources. Prerequisites: 25 credits in history including History 3-4; knowledge of at least high school Latin. Five credits. VIII-IX; TTh; 218aLib. Mr. White. See also courses in Economic History.

European History

101f-102w.† The French Revolution and Napoleonic Era. Prerequisites: 20 credits in social science including 10 credits in history. Reading knowledge of French desirable. Six credits. I; TThS; 111Lib. Mr. Harding.

104s. The Near East, Modern. The Saracen Empire, Turkey, the Balkan States, and European diplomacy in the East since the beginning of the Middle Ages. Prerequisites: 20 credits in social science group including 10 credits in history. Five credits. III; MTThFS; 111Lib. Mr. Davis.

107f-108w. Europe, 1848-1914. Prerequisites: 20 credits in social science; if History 1-2 is not offered as a prerequisite, consent of instructor must be obtained. A reading knowledge of French and German will be helpful. Eight credits. VII; MTThF; 111Lib. Mr. Steefel.

111w. European Background of American Immigration. The movement of population from Europe to America in the nineteenth century, with the emphasis on the economic, political, social, and religious forces. Prerequisites: 20 credits in social science group. Four credits. VI; TWThF; 111Lib. Mr. Stephenson.

119s. The Renaissance and Reformation. Especial emphasis upon the work of individual men and upon ideas rather than upon politics and institutions. Prerequisites: 20 credits in history. Five credits. IV; MTWFS; 111 Lib. Mr. Krey.

120f. Medieval Civilization. A study of the social and intellectual development of Europe from the period of the German migration to the end of the thirteenth century. Prerequisites: 20 credits in history. Five credits. IV; MTWFS; 112Lib. Mr. Krey.

131f-132w.† The Formation and Fall of the Modern German Empire. The principal emphasis is on the period since 1848. The work of Bismarck and the Empire under William II. Prerequisites: 20 credits in social science, including 10 credits in history. Six credits. (Not offered in 1923-24.) Mr. Ford.

157w-158s. Selected Topics in Nineteenth-Century History. Discussion based on a wide range of reading. Prerequisites: 25 credits in social science including History 107-108 or 101-102. A reading knowledge of French or German will be required. Six credits. VII, VIII; TTh; 218aLib. Mr. Ford.

164w. Studies in the Crusades. Prerequisites: 25 credits in history; knowledge of at least high school Latin. Five credits. VIII, IX; TTh; 218aLib. Mr. Krey.

201f-202w-203s. Historical Bibliography and Criticism. Required of candidates for advanced degrees in history who do not present evidence of similar training elsewhere. I; S; 112Lib. Mr. Ford, Mr. White, and others.

HOME ECONOMICS

Professor Wylle B. McNeal; Associate Professors Alice Biester, Marion Weller; Assistant Professors Ethel Phelps, Alice Child, Amy P. Morse, Nola Treat, Ella Anderson.

Prerequisites.—For major work, 27 credits including Courses 13, 22, and 45 in home economics or their equivalent, 10 credits in general chemistry, 5 credits in organic chemistry, 5 credits in quantitative analysis, and 15 credits in biological science. For minor work 9 credits in the department and any additional prerequisite work needed to pursue the courses selected.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

103f,w,s. Dietetics. The fundamental principles of human nutrition as applied to the feeding of individuals and groups under conditions of health, and under such pathological conditions as are chiefly dependent upon dietetic treatment. Three to five credits. Prerequisite: Course 108. Fall, spring, VI, VII; MTWThF; 203, 207HE. Winter, Sec. 1, VI, VII; MTWThF; 203, 207HE. Sec. 2, I, II; MTWThF; 203, 207HE. Miss Biester, Miss Anderson.

105f,w,s. Experimental Cookery. An intensive study of problems in foods and food preparation with individual laboratory problems. Three credits. Prerequisites: Courses 22, 23. I, II; MWF; 207HE. Miss Child.

106f,w,s. Experimental Cookery. Same as 105 except that additional work will be required. Five credits. I, II; MWF; 207HE. Extra hours arranged. Miss Child, Miss Kolshorn.

108f,w,s. Nutrition II. A study of metabolism including work on tissues, blood, and urine. Five credits. Prerequisite: Course 23. Fall, spring, III, IV; MTWFS; 211, 213HE. Winter, Sec. 1, III, IV; MTWFS;

211,213HE. Sec. 2, I, II; MTWThF; 211, 213HE. Miss Anderson, Miss McMahon.

109s. Advanced Nutrition. A study of selected quantitative methods applicable to investigations relating to digestion and metabolism. Five credits. Prerequisites: Course 108, Agr. Biochem. 2. Lect. III; TS; 106HE; Lab. VI-IX; TTh; 311HE. Miss Biester, Miss Anderson.

122w,s. Advanced Textiles. An experimental study of textile problems such as shrinkage and other laundering results; textile legislation and special economic problems. Three credits. Prerequisites: Course 3, Agr. Biochem. 3, Econ. 5 or parallel. Winter, VI-VIII; TTh; 307, 311HE. Spring, VI, VII; MWF; 307, 311HE. Miss Weller, Miss Phelps.

123w,s. Clothing Economics. General consideration of the economic problems in clothing production; women's responsibility for conditions in textiles and clothing industries; study of the budget for clothing and household textiles; hygiene and standardization of dress. Two credits. Prerequisites: Course 13, Econ. 5. III; TTh; 313HE. Miss Weller.

131f,w,s. Home Management: House Planning and Equipment. House plans and kitchen arrangements studied from viewpoint of the home maker. Study of principles underlying selection and arrangement of house furnishing and equipment, including such subjects as walls, rugs, furniture, hangings, and accessories. Special problems for graduate students. Five credits. Prerequisites: Courses 52, 53. Fall, winter, III, IV; MTWFS; 401HE. Spring, I, II; MTWThF; 401HE. Miss Morse.

110s. Special Problems in Dietetics. An intensive study involving assigned readings, discussions, and field work. Three credits. Prerequisite: Course 103. Lect. VIII; MW; 213HE. Lab. One full afternoon; ar. Miss Biester, Miss Anderson.

111s. Special Food Problems. A continuation of experimental cookery involving more advanced problems. Three credits. Prerequisites: Course 105, Agr. Biochem. 2. VI, VII, VIII; TTh; 207HE. Miss Child.

112s. Special Food Problems. Same as 111s. Five credits. Prerequisites: Course 105, Agr. Biochem. 2. VI, VII, VIII; TTh. Extra hours arranged. 207HE. Miss Child.

126s. Problems and Application of Quantitative Methods in Textile Analysis with special reference to establishing standards for fabrics. Three credits. Prerequisites: Course 122, Agr. Biochem. 2. Hours and days arranged. 311HE. Miss Phelps.

134s. Budget Problems. An intensive study of problems relating to individual and family budgets involving readings, discussions, and field work. Three credits. Prerequisites: Courses 34, 35, 103, 123. Economics 90 or parallel. VII; MW. Lab. To be arranged.

151s. Institution Management Problems. Organization; service; institution-planning, decoration, and equipment; budgets, and the study of different types of institutions. Four credits. Prerequisites: Course 61, 63. IV; WF; 106HE. III, IV; S; 106HE. Miss Treat.

203w-204s. Home Economics Problems. Opportunity is offered for the investigation of selected problems in home economics. Five credits. Hours and days arranged. Miss McNeal.

205-206-207. Home Economics Seminar. A critical study of selected topics and recent advances in home economics involving outside reading, oral and written reports. Two credits each. Hours and days arranged. Miss Biester.

HORTICULTURE

Professors William H. Alderman, Herbert K. Hayes; Associate Professors Wilfrid G. Brierley, LeRoy Cady; Assistant Professor William T. Tapley.

Prerequisites.—For major work, 15 credits; for minor work, 9 quarter credits in the department in addition to two years in botany and one year in entomology.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

107f. Orchard Management. A detailed study of the various operations in orchards and berry fields. Operating costs and profits. Lectures, laboratory, and individual problems. Prerequisite: Horticulture 6, botany, 9 credits. Three credits. IV; TS. VI, VII; W; 210Hr. Mr. Brierley.

109f,w. Principles of Genetics. Same as Agronomy and Farm Management 131. Lectures and laboratory work designed to familiarize the student with the underlying principles of breeding. Heredity, variation, biometry, and evolution are emphasized. Prerequisites: botany, 9 credits or animal biology, 9 credits. Three credits. Lect. I; ThS; 102Hr. Mr. Beaumont,* Mr. Wilcox. Lab. Sec. 1. I, II; T; 212Hr. Sec. 2. III, IV; T; 212Hr. Sec. 3. VI, VII; W; 212Hr. Mr. Beaumont, Mr. Wilcox.

110w. Horticultural Crop-Breeding. Applied genetics is emphasized. Methods of breeding each of the important horticultural crops with special attention to experiment station investigations and to the methods used by plant breeders. Prerequisite: Horticulture 109 or Agronomy 131. Three credits. III; TThS; 215Hr. Mr. Beaumont.

* Mr. Beaumont will teach in the fall quarter and Mr. Wilcox in the winter quarter.

111f. Systematic Pomology. A study of fruit varieties. Lectures, laboratory, and a survey of the literature. Prerequisites: Horticulture 6, botany, 9 credits. II; TTh; VI, VII; Th; 8Hr. Mr. Brierley.

131f. Advanced Vegetable Production. A study of the business of vegetable-gardening. Special problems for investigation and research, reviews and reports on recent literature. Prerequisite: Horticulture 32, botany, 9 credits. Three credits. III; TTh. III, IV; S; 210Hr. Mr. Tapley.

132f. Systematic Olericulture. The origin, botany, varieties, and types of the different vegetables, their characteristics and adaptation to different cultural and market conditions, identification and classification studies, judging, and exhibiting. Prerequisite: Horticulture 32, botany, 9 credits. III; MW; V, VI; Th; 102Hr. Mr. Krantz.

133f. Commercial Truck-Growing. Truck-growing centers of the United States, cultural methods used in producing various truck crops, special machinery and equipment, market methods, shipping points. Adaptation of truck crops to Minnesota, commercial production for canneries; handling; shipping to market. Prerequisite: Horticulture 32, botany, 9 credits. Three credits. IV; MWF. Mr. Tapley.

135w. Potato Production. A study of the origin, botany, regional distribution, economic importance, group classification, standardization of varieties according to soil, climate, and markets. Identification, exhibiting, judging, cultural methods, seed selection and certification, marketing and utilization. Prerequisite: Horticulture 6 or 32, botany, 9 credits. III; MW; VI, VII; Th; 102Hr. Mr. Krantz.

151f. Advanced Floriculture. Lectures, assigned readings, laboratory, and special problems dealing with the culture, botany, and history of florists' plants and methods of greenhouse management. Prerequisites: Horticulture 50, botany, 9 credits. Three credits. Ar. Mr. Cady.

190f-191w-192s. Special Problems. A study of problems based upon the work given in the preceding courses. Two to 4 credits per quarter. Mr. Alderman.

193f-194w-195s. Horticultural Seminar. Reports and discussions of problems and investigational work. Required of graduate students. One credit per quarter. Horticultural staff.

COURSES PRIMARILY FOR GRADUATE STUDENTS

201f-202w-203s-204su. Fruit-Growing Research. Special problems in fruit culture or disposal. Students will be required to continue the work over at least one summer to arrange for concentration on problems at the most appropriate season. Open to those who have specialized in fruit-growing. Three to 6 credits per quarter. Mr. Alderman, Mr. Brierley.

209f-210w-211s-212su. Fruit-Breeding Research. Consists of (a) some thesis problem, (b) development of laboratory technique in breeding. Work involves reading in genetics, cytology, biometry. Students required to continue work over one summer. Open to limited number specializing in fruit-breeding. Three to 6 credits per quarter. Mr. Alderman, Mr. Hayes.

213f-214w-215s, or Agronomy and Farm Management 203f,w,s. Plant-Breeding Seminar. History of plant-breeding, application of recent genetic theories to crop improvement and a discussion of research problems. Weekly meetings throughout the year. Prerequisite: Horticulture 109. Maximum of 3 credits. Mr. Hayes.

231f-232w-233s-234su. Vegetable-Growing Research. Special problems in vegetable culture. Students will be required to continue the work over at least one summer. Open to those who have specialized in vegetable-growing. Three or 6 credits per quarter. Mr. Tapley.

242w. Methods and Interpretation of Horticultural Research. A critical analysis of the more important horticultural investigations, together with a study of methods and organization of research work in horticulture. Two credits. Mr. Alderman.

243w. Advanced Topics in Horticulture.

LATIN

Professor Joseph B. Pike;[1] Assistant Professor Robert V. Cram.

Prerequisites.—Any four of Courses 21-53, and 6 credits in addition selected from standard courses. A reading knowledge of French, German, or Greek is required of candidates for the Master's degree.

The degree of master of arts: For a major in Latin, Course 211-212-213, and in addition one course each quarter selected from Courses 121-133. The student will be expected to choose for his thesis some problem connected with one of these courses. Besides, a minor is to be carried throughout the year in one of the following departments: Comparative Philology, English, German, Greek, History, Romance Languages, or Scandinavian. For a minor in Latin, Course 211-212-213 or one course each quarter selected from Courses 121-133.

Candidates for the degree of doctor of philosophy in Latin will be expected to spend at least three years in preparation and will carry each quarter in addition to one seminar course and one of the courses listed below, one course in advanced Greek (i.e., in advance of two years of preparatory Greek). A knowledge of Greek and Roman history, Greek and Roman literature, and a special knowledge of a particular Latin author, or group of authors, will be required. In addition to the particular author or authors assigned the candidate will be expected to have read in the original the following list of Latin authors:

[1] Absent on leave, 1923-24.

Caesar: A considerable portion of the Gallic War and the Civil War.
Catullus: All except LXIII-LXVIII.
Cicero: Fourteen orations (*e.g.,* Roscius Amerinus, Verres Actio Prima, Imperium Pompeii, Catilinarians I-IV, Murena, Archias, Milo, Marcellus, Ligarius, Deiotarus, Philippics II; Cato Maior, Laelius, Tusculan Disputations, Book I.
Horace: All.
Juvenal: Satires I, III, IV, VII, VIII, X, XI.
Livy: Books I, II, XXI, XXII.
Lucretius: Books I-III, V.
Martial: At least one half.
Ovid: About four thousand verses of the Metamorphoses.
Plautus: Amphitruo, Aulularia, Captivi, Menaechmi, Miles Gloriosus, Mostellaria, Rudens, Trinummus.
Pliny the Younger: At least one half.
Quintilian: Book X, C. 1.
Suetonius: Iulius, Augustus, Tiberius, Nero, Domitian.
Tacitus: Annals I-VI or XI-XVI.
Terence: Adelphoe, Andria, Hautontimorumenus, Phormio.
Virgil: All except the minor poems.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

121. Advanced Vergil. Selection from Books 7-12 of the *Aeneid.* Prerequisites: any two of Courses 51-53 or an equivalent. Three credits. II; MWF; 109F. Mr. Cram.

122w. Cicero's Letters. Prerequisites: any two of Courses 51-53 or an equivalent. Three credits. II; MWF; 101F. (Not offered in 1923-24.) Mr. Pike.

123s. Medieval Latin. Selected documents illustrating the conflict between church and state in the Middle Ages. Selections from *History of the Franks,* by Gregory of Tours. Prerequisites: any two of Courses 51-53 or an equivalent. Three credits. II; MWF; 109F. (Not offered in 1923-24.) Mr. Pike.

131f. Juvenal. Selection from Juvenal's work. Prerequisites: any two of Courses 51-53 or an equivalent. Three credits. Alternates with Course 121. II; MWF; 107F. (Not offered in 1923-24.) Mr. Pike.

132. Seneca's Epistles. Prerequisites: any two of Courses 51-53 or an equivalent. Three credits. Alternates with Course 122. II; MWF; 107F. Mr. Cram.

133. Petronius and Martial. Prerequisites: any two of Courses 51-53 or an equivalent. Alternates with Course 123. Three credits. II; MWF; 107F. Mr. Cram.

201f-202w-203s. TACITUS. (Graduate seminar, but open to students who register for honors in Latin.) Prerequisites: seven years of Latin or any two of Courses 51-53. Three credits. VII and VIII; Th; 108F. MR. CRAM.

221-222-223. GRADUATE SEMINAR. Three credits. Ar. MR. CRAM.

MATHEMATICS AND MECHANICS

Professors WILLIAM E. BROOKE, WILLIAM H. BUSSEY, HANS H. DALAKER, WILLIAM F. HOLMAN, DUNHAM JACKSON, WILLIAM H. KIRCHNER, FRANCIS P. LEAVENWORTH (Astronomy); Associate Professors RAYMOND W. BRINK, WILLIAM L. HART, JACOB O. JONES, ROYAL R. SHUMWAY, ANTHONY L. UNDERHILL; Assistant Astronomer WILLIAM O. BEAL; Instructor GLADYS GIBBENS.

Professor R. W. Brink is chairman of the group. Students majoring in mathematics should consult him.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

Courses offered by members of the faculty of the College of Science, Literature, and the Arts.

106f. DIFFERENTIAL EQUATIONS. Three credits. III; MWF; 105F. MR. HART.

107w-108s. ADVANCED CALCULUS. Three credits per quarter. III; MWF; 105F. MR. BRINK.

111f-112w-113s. CELESTIAL MECHANICS. Three credits per quarter. MR. BEAL. (This course is identical with Astronomy 111-112-113.)

140w. METHOD OF LEAST SQUARES. Three credits. MR. LEAVENWORTH. (This course is identical with Astronomy 140.)

Courses offered by members of the faculty of the College of Engineering and Architecture.

127f,w,s. TECHNICAL MECHANICS. Five credits. MR. WILCOX.

128f,w,s. STRENGTH OF MATERIALS. Five credits. MR. HOLMAN.

129f,w,s. HYDRAULICS. Four credits. MR. JONES, MR. BOEHNLEIN.

150w. ADVANCED MATHEMATICS FOR ELECTRICAL ENGINEERS. Three credits. MR. HERRMANN.

151f-152w-153s. DIFFERENTIAL EQUATIONS AND ADVANCED CALCULUS APPLIED TO ENGINEERING PROBLEMS. Three credits per quarter. MR. DALAKER, MR. HARTIG.

161f-162w-163s. ADVANCED TECHNICAL MECHANICS. Three credits per quarter. MR. WILCOX.

171f-172w-173s. Aerodynamics. Three credits per quarter. Mr. Boehnlein.

180s. Advanced Strength of Materials. Three credits. Mr. Priester.

191f. Hydraulic Motors and Pumps. Three credits. Mr. Jones.

COURSES PRIMARILY FOR GRADUATE STUDENTS

Courses offered by members of the faculty of the College of Science, Literature, and the Arts.

206f-207w-208s. Theory of Functions of Real and Complex Variables. Three credits per quarter. Mr. Hart.

281f-282w-283s. Advanced Theory of Functions. Three credits per quarter. Mr. Jackson.

Courses offered by members of the faculty of the College of Engineering and Architecture.

261f-262w-263s. Functions of a Complex Variable. Three credits per quarter. Mr. Dalaker.

271f-272w-273s. Advanced Dynamics. Routh's *Dynamics,* Vol. II. Three credits per quarter. Mr. Brooke.

277f-278w-279s. Advanced Statistics. Three credits per quarter. Mr. Brooke.

The following courses have been offered from time to time in the past, and similar courses, or other courses of corresponding grade, will be provided at any time when there is sufficient demand for them.

Courses offered by members of the faculty of the College of Science, Literature, and the Arts.

Differential Geometry.
Projective Geometry.
Modern Higher Algebra.
The Mathematics of Small Vibrations.
The Theory of Numbers.
The Galois Theory of Equations.
Higher Plane Curves.
Advanced Differential Equations.
Exterior Ballistics.
The Calculus of Finite Differences.
Modern Theories of Integration.
Approximation by Polynomials and Trigonometric Sums.
Theory of Linear Differential and Integral Equations.

Courses offered by members of the faculty of the College of Engineering and Architecture.

Advanced Descriptive Geometry.
Perspective.
Vector Analysis.

Modern Analysis.
Fourier's Series and Spherical Harmonics.
Advanced Dynamics, Vol. I, Routh's *Dynamics.*
Mathematical Theory of Elasticity.
Hydrodynamics.
Advanced Topics in Functions.

Beginning with the year 1924-25 a course in the Mathematical Theory of Statistics will be offered by members of the faculty of the College of Science, Literature, and the Arts.

MECHANICAL ENGINEERING

Professors John J. Flather,* William S. Holman, Frank B. Rowley; Associate Professors John V. Martenis, Carl Shipley, Charles F. Shoop.

Industrial Engineering

120w. Industrial Plants. Factory organization and construction for economical manufacture. Organization of the industry. Location and type of buildings, power development. Layout of plant. Routing systems and machine layout. Heating and ventilating requirements. Distribution of power; internal transportation. Lectures, recitations, and drawing room practice. Three credits. Open to seniors with 15 or 16. Mr. Flather, Mr. Shipley.

121s. Production Methods. Principles and practice involved in economical production. Standardization. Requirements for uniformity and interchangeability. Jigs, fixtures, and special equipment; gages and inspection systems. Division of labor. Lighting, heating, and sanitation. Conveying, handling, and stores control. Fatigue elimination. Three credits. Open to seniors with 15 or 16. Mr. Shipley.

223f. Industrial Management. General principles. The Taylor system; wage, bonus, and profit-sharing systems. Maintenance and depreciation. Purchasing. Allocation of cost, overhead, and machine burden. Graphical representation. Prerequisite: 121. Mr. Flather.

224w. Industrial Management Laboratory. Planning department. Time and motion studies; rate-setting. Instruction cards. Production control. Shop practice with investigations in local factories. Lectures, assigned reading, practice, and reports. Three credits. Prerequisite: 223f. Mr. Shipley.

225s. Industrial Management. Labor administration. Foreman-training. Training the worker; job analysis. Employment and turnover; the human element, service departments. Stabilization of labor. Lectures, reading, shop visits, and reports. Three credits. Prerequisite: 224. Mr. Flather.

* On leave of absence, 1923-24.

226f. Safety Engineering. Safety of the worker; fire and other hazards; prevention of industrial accidents. Compensation laws. Fire prevention: construction; automatic sprinkler systems. Effect of safety on production. Factory sanitation. Safety organization. Lectures, assigned reading, factory inspections, and reports. Prerequisite: 121. Three credits. Mr. Shipley.

227w-228s. Industrial Engineering Problems. Special investigations of practical problems and suggested methods of procedure. Lectures, assigned reading, shop visits and reports. Three credits. Prerequisite: 223, 224, 225 or registered in 223, 224, 225. Graduates only. Mr. Flather, Mr. Shipley.

Machine Design

131f-132w-133s. Advanced Engineering Design. Original design, including machinery for changing size and form, cranes, pumping, transmission machinery, and engineering appliances. Lectures, problems, and drawing room practice. Three credits per quarter. Prerequisite: 35. Mr. Flather, Mr. Rowen, Mr. Gauvreau.

Steam Engineering

135f. Steam Engine Design. Calculations and working drawings for a high speed automatic or Corliss steam engine. Theoretical diagrams, inertia forces; determination of details. Senior option. Three credits. Prerequisite: 42 or equivalent. Mr. Flather, Mr. Rowen.

144f. Heat Engines. Elementary thermodynamics. Properties of steam; types and details of steam engines; valve gears; governors; compound engines. Condensers and air pumps. Courses 144, 145, 146 are arranged for students in electrical engineering, and are accompanied by three hours' work in laboratory each week. Three credits. Prerequisite: M.&M. 26. Mr. Rowley, Mr. Robertson, Mr. Rhame.

145w. Heat Engines. Continuation of Course 144. Combustion and fuels; boilers, smoke prevention. Selection of engines and boilers. Courses 144, 145, 146 are arranged for students in electrical engineering and are accompanied by three hours' work in the laboratory each week. Three credits. Prerequisite: 144. Mr. Rowley, Mr. Robertson, Mr. Rhame.

146s. Heat Engines. Elementary study of steam turbines and gas engines. Courses 144, 145, 146 are arranged for students in electrical engineering and are accompanied by three hours' work in laboratory each week. Three credits. Prerequisite: 145. Mr. Rowley, Mr. Robertson, Mr. Rhame.

147w. HEAT ENGINES. Elementary thermodynamics. Properties of steam; calorimeters; pyrometry; types and details of steam engines; valve gears; governors; compound engines. Condensers and pumps. Combustion, and fuels; evaporation; steam boilers, smoke prevention. Includes four hours' work in laboratory per week. Four credits. Prerequisite: M.&M. 26. MR. SHOOP, MR. TUVE.

148s. HEAT ENGINES. Elementary study of steam turbines and gas engines; gas producers. Refrigeration. Air compressors. Includes four hours' work in laboratory per week. Three credits. Prerequisite: 147. MR. SHOOP.

149f,w,s. HEAT ENGINES. A brief course for students in civil engineering and the course in architectural engineering includes four hours' laboratory per week. Four credits. Prerequisite: M.&M. 26. MR. TUVE.

151s. THERMODYNAMICS. The mechanical theory of heat as applied to steam oil, gas, and hot air engines and allied power plant machinery and accessory equipment, including compressors, injectors, reheaters, and refrigerating apparatus. Three credits. Prerequisites: M.&M. 127, 128, 129. MR. SHOOP, MR. ROWEN.

152w. STEAM TURBINES. Theory and practice applied to various types. Thermodynamics and mechanical analysis of problems involved in the design of nozzles, blades, rotors, bearings, and governors. Condition of operation; systems of transmission; lubrication; economy; field of service. Laboratory investigation. For seniors. Three credits. Prerequisite: 151. MR. SHOOP, MR. ROWEN.

181w. ADVANCED GENERAL LABORATORY. Indicator practice, valve-setting, separating and throttling calorimeters, tests of steam engines, gas engines, pumps, air compressors, blowers, turbines, boilers, and power plant. Four actual hours. Prerequisite: 84. MR. ROWLEY, MR. SHOOP, MR. ROBERTSON.

182f,w. ADVANCED STEAM LABORATORY. Tests of steam turbines, flow of steam through nozzles and pipes. Tests of compound and triple expansion engines, condensers, superheaters, and boilers. Two credits. Prerequisite: 151. MR. SHOOP, MR. TUVE.

251f. ADVANCED THERMODYNAMICS. Expansion of Course 151. Theories of heat as applied to combustion and kinetic engines. Reversible changes of state of wet and superheated vapors. Non-reversible flow and efflux of wet and superheated vapors, throttling through orifices, valves, flow into receivers, communicating vessels. Critical points, liquefaction and mixtures of gases. Gas cycles. Treatment of imperfect gases. Three credits. Prerequisite: 151. MR. SHOOP.

Heating, Ventilation, and Refrigeration

153f. Heating and Ventilating. Principles of heating and ventilation. Construction and operation of heating apparatus. Furnaces, steam, hot water, vapor, vacuum, and fan systems of heating; ventilation. Lectures, recitations, and designs. For seniors.—Required of senior architectural engineers. Four credits. Prerequisites: M.&M. 127, 128, 129. Mr. Martenis.

154s. Heating and Ventilating. Same as Course 153 with the omission of design problems. Arranged for students in the course in Architecture. Two credits. Prerequisite: M.&M. 92. Mr. Martenis.

156s. Compressed Air and Refrigerator Machinery. (a) Air compressors and motors; power transmission by compressed air. (b) Principles of refrigeration. Various types of refrigerating machines, refrigerants applications to ice-making, cold storage, cooling of air, liquids, and solids. Lectures and recitations. Three credits. Prerequisite: 151. Mr. Rowen.

255f,w,s Advanced Heating and Ventilating. An advanced course for graduates. To be taken in connection with research work in the laboratory, Course 287. Three credits. Prerequisite: 153. Mr. Rowley.

257w. Mechanical Equipment of Buildings. Appliances used; heating, ventilating, plumbing systems; piping for fire protection, compressed air, gas, and vacuum cleaning; elevators. Choice of systems. Theory and practice of designing and detailing lay-outs. Equipment designs for various types of buildings. Three credits. Prerequisite: Phys. 43. Mr. Rowley, Mr Martenis.

Automotive and Aeronautical Engineering

150f. Gas Engines and Producers. Laws of gases; gas cycles. Otto, semi-Diesel, and Diesel engines. Mechanism of various types. Carburetion, governing, cooling, lubrication. Principles of design. Gas producers; types, suction, pressure, blast furnace. By-products recovery. Three credits. Prerequisites: 41, 43. Mr. Rowley.

183f,w. Power and Gas Engine Laboratory. Tests of gas and gasoline engines and gas producers. Power and lighting plants. Two credits. Prerequisite: registration in 150. Mr. Rowley, Mr. Shoop.

136f,w. Gas Engine Design. Calculations and working drawings of a gas motor for heavy duty tractor, truck, marine, or other service. Theoretical diagrams and details of parts. Senior option. Three credits. Prerequisite: registration in 150. Mr. Rowley, Mr. Gauvreau.

137w. Advanced Gas Engine Design. Continuation of Course 136. Three credits. Prerequisite: 136. Mr. Gauvreau.

141w. Automobile and Motor Truck Engines. Continuation of 150 with special reference to automobile and motor truck engines. Theoretical consideration of engine parts and accessories, carburetion of various fuels; the Diesel principle as applied to small high speed engines. Lectures, recitations, and problems. Three credits. Prerequisite: 150. Mr. Rowley. Mr. Gauvreau.

142s. Automobile and Motor Trucks. Theory and design of the automobile and motor truck chassis, including frames, brackets, clutches, transmission, axles, steering gears, and springs. Lectures, recitations, and problems. Three credits. Prerequisite: 141. Mr. Gauvreau.

231f,232w,233s. Automobile and Motor Truck Design. A course covering the theory and design of the automobile and motor truck engine and chassis in which the design of the complete engine, transmission and chassis is carried out. Three credits each quarter. Lectures and drawing room work. Graduates only. Mr. Gauvreau.

237s. Gas Tractor Design. Selection of wheel sizes; horsepower weight and drawbar pull. Bearing pressures; ratios and strength of gearing. Details of principal parts. Senior option. Three credits. Prerequisite: 136. Mr. Rowley, Mr. Gauvreau.

293f,w,s. Aeronautical Engineering. Design of aerial propellers, aeroplane engines. Application of theory of propellers and gasoline engines to aeroplanes. Includes calculations and drawings for high-speed, multi-cylinder, light-weight engine; balancing reciprocating parts; uniform torque; theoretical diagrams. Three credits. Prerequisite: 150. Mr. Gauvreau.

294f,w,s. Aeroplane Design. Calculations and drawings for a given aeroplane; stability, strength, propulsion, and motive power required. Three credits. Prerequisite: 136. Mr. Gauvreau.

281f,282w,283s. Automobile-Testing and Research. Dynamometer and road tests including overall efficiency of cars and motor trucks, transmission efficiencies, performance of cars at various speeds, fuel consumption, effect of road surface on traction, efficiencies, and general performances. Special research problems. Three credits each quarter. Graduates only. Mr. Rowley.

295s. Motor Truck Transportation. Problems involving motor truck transportation, capacity of trucks, trailers, drawbar pull. Efficiencies. Effect of road surface. Freight-handling. Analysis of costs of truck operation and maintenance. Relative costs of transportation. Three credits. Prerequisite: 142. (Not offered in 1923-24.)

Power Plant Engineering

162f. Power Plant Machinery. Advanced study and application of engines, stokers, boilers; coal-handling equipment and accessories. Lectures, recitations. Three credits. Prerequisite: M.E. 43. Mr. Rowen.

163w. Power Engineering. Principles of thermodynamics applied to power plant equipment. Three credits. Prerequisite: M.E. 162. Mr. Rowen.

164s. Elements of Power Plant Design. Problems in design of power plant elements such as condensers, air pumps, boilers, turbines, piping, and separators. Three credits. Prerequisite: M.E. 163. Mr. Rowen.

166s. Water Turbines. The theory of operation, design, construction, and regulation of water turbines. Turbine-testing; characteristics, selection of type. Cost of turbines and water power. Senior option. Three credits. Prerequisite: M.&M. 129. Mr. Rowen.

265f-266w. Power Plant Design. Problems, designs, and estimates for power plants and central stations. Selection of motive powers, relative advantages of steam and producer gas plants, choice of engines and boilers; pumps, shafting, piping, and accessories. Three credits per quarter. Prerequisite: M.E. 164. Mr. Rowen.

267s. Power Plant Management. Operation and maintenance of boilers, engines, gas producers, gas engines, steam turbines, and accessory apparatus. Smoke prevention. Flue gas analysis. Power plant finance. Daily logs and power cost. Three credits. Prerequisite: M.E. 164. Mr. Rowen.

Railway Mechanical Engineering

271f. Railway Technology. The practical details of construction of locomotives. A systematic course of visits to the various railroad shops in the vicinity. Lectures and recitations. One credit. Prerequisites: M.&M. 127, 128, 129. Mr. Martenis.

272f-273w-274s. Railway Design and Locomotive Construction. Locomotive and car details; the locomotive boiler, linkages, and assembled parts. Construction of locomotives: frames, springs, equalizing arrangements, running gear, brakes, trucks, lubrication. Engine details; heat insulation, cylinder proportions. Lectures and assigned reading. Four credits per quarter. Prerequisite: 271, or registration in 271. (Not offered in 1923-24.)

278s. Locomotive Road Tests. Tests on locomotives and trains. Dynamometer car and drawbar pull. Three credits. Prerequisite: 271, 272. Mr. Flather and assistants. (Not offered in 1923-24.)

General Courses and Research

190f-191w-192s. SEMINAR. Same as Course 93. Arranged for seniors. One credit per quarter. MR. FLATHER, MR. ROWLEY, MR. ROWEN.

290f-291w-292s. SEMINAR. Same as Course 93. Arranged for graduate students. One credit per quarter. MR. FLATHER, MR. ROWLEY, MR. ROWEN.

184s. ADVANCED ENGINEERING LABORATORY. Opportunity will be offered for carrying on investigations in connection with tests of power plants, refrigerators, air compressors, blowers, and fans. Also automobile-testing and gas engine investigations. Two credits. Prerequisites: 182, 183. MR. ROWLEY, MR. SHOOP.

287f-288w-289s. MECHANICAL ENGINEERING RESEARCH. Courses may be elected which involve investigations in connection with fuels, lubricating oils, steam and gas engines, heating and ventilating, and other problems as selected. Reports, special problems, and related tests. Three credits per quarter. Prerequisite: 181 or registration in 181. MR. FLATHER, MR. ROWLEY, MR. ROWEN, MR. SHOOP.

MEDICINE

(Including General Medicine, Dermatology, and Nervous and Mental Diseases)

The graduate work in the Department of Medicine is designed to prepare students for practice of the specialty of internal medicine, research in the problems of general medicine, and for the specialty of nervous and mental diseases, as the case may be, and to train men as teachers in their respective fields. Prospective students who have had no special work in addition to that of the undergraduate course in physiology, physiologic chemistry, therapeutics, experimental medicine, or pathology are advised to devote a year or more to these subjects before entering the regular three-year graduate course. Throughout the course it is recommended that a minor be carried in one or more of the following departments: Physiology, Pharmacology, Pathology, Immunology, and Pediatrics. For students specializing in nervous and mental diseases, minors in anatomy and psychology are especially valuable, and for those desiring it, work would be arranged in the Department of Ophthalmology and Oto-Laryngology, giving a special opportunity to study lesions of the eye occurring in systematic disorders. In the Medical School, during at least the third year of the three-year fellowship, the fellow acts as an officer of the clinic with definite responsibility in the care of patients in the University Hospital.

For courses of study see special bulletin of graduate courses in medicine.

METALLOGRAPHY

Professor Oscar E. Harder; Instructors R. L. Dowdell, C. M. Reasoner.

Prerequisites.—For major work, adequate preparation in the sciences fundamental to metallography (chemistry, physics, geology, technical subjects), the general requirements being fulfilled. For minor work, the prerequisites to the courses to be pursued.

Exemption from the language requirements for the Master's degree may be made in individual cases.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

150f. Metallography for Electrical Engineers. Principles of metallography, including pyrometry, thermal analysis, constitution diagrams, microscopic and photomicrographic technique; study of typical alloys with special reference to electrical resistance, conductivity, magnets, etc. Laboratory work and demonstrations. Two lectures, three laboratory hours per week. Three credits. I; MW; 315M. VI, VII, VIII; M; 307M. Mr. Harder, Mr. Dowdell.

151w. Advanced Metallography for Electrical Engineers. Continuation of 150. Two lectures, three laboratory hours per week. Prerequisite: Course 150. Three credits. I; MW; 315M. VI-VIII; M; 307M. Mr. Harder, Mr. Dowdell.

153f-154w-155s. Metallography. (Long course for metallurgical engineers.) Theory of metallic alloys. Metallographic technique. Properties of metals and alloys. Metallography of iron and steel and commercial alloys. Technical metallography. Three lectures, four laboratory hours per week each quarter. Prerequisites: Chemistry 28, Physics 43s. Five credits per quarter. VI or VII; MWF; 305M. VI-IX; T; 307M. Mr. Harder, Mr. Dowdell.

156f. Metallography for Mechanical Engineers. Similar to 150 but specially arranged for students in mechanical engineering. Two lectures, three laboratory hours per week. Three credits. III; ThS; 112M. VI-VIII; W or F; 307M. Mr. Harder, Mr. Dowdell, Mr. Reasoner.

157w. Advanced Metallography for Mechanical Engineers. Continuation of 156. Two lectures, three laboratory hours per week. Three credits. Prerequisite: Course 156. III; ThS; 112M. VI-VIII; W or F; 307M. Mr. Harder, Mr. Dowdell, Mr. Reasoner.

160f. Metallography for Chemical Students. Principles of metallography, including constitution diagrams, preparation and standardization of thermocouples, preparation and thermal analysis of alloys, microscopic examination and making of photomicrographs; typical alloys systems as iron-carbon (steel and cast iron), some non-ferrous

alloys. Prerequisite: Chemistry 20. Two lectures and 3 laboratory hours per week. Three credits. II; MW; 112M. VI-VIII; Th; 307M. Mr. HARDER, Mr. DOWDELL.

161w. ADVANCED METALLOGRAPHY FOR CHEMICAL STUDENTS. Metallography and heat treatment of iron and steel, including alloy steels, commercial uses of various steels, and engineering specifications. Prerequisite: Course 160. Two lectures and three laboratory hours per week. Three credits. II; MW; 112M. VI-VIII; Th; 307M. Mr. HARDER, Mr. DOWDELL.

162s. ADVANCED METALLOGRAPHY FOR CHEMICAL STUDENTS. Metallography of the non-ferrous metals with a study of the constitution diagrams, properties, and uses of important commercial alloys. Prerequisite: Course 160. Two lecture and three laboratory hours per week. Three credits. H; MW; 112M. VI-VIII; Th; 307M. Mr. HARDER, Mr. DOWDELL.

163f-164w-165s. ADVANCED METALLOGRAPHY. Technical and scientific research. The study of steel rails, automobile and locomotive parts, tool steels, etc. Special problems in metallography with outside reading. Seminar work in the recent advances in metallography. Prerequisites: Courses 151, 155, 157, or equivalent. Credits and hours to be arranged. 305M. Mr. HARDER.

COURSES PRIMARILY FOR GRADUATE STUDENTS

201f-202w-203s. ADVANCED METALLOGRAPHY FOR GRADUATE STUDENTS. Intended primarily for research work. Credits and hours to be arranged. 305M. Mr. HARDER.

OBSTETRICS AND GYNECOLOGY

For staff and courses of study offered, see special bulletin of graduate work in medicine.

OPHTHALMOLOGY AND OTO-LARYNGOLOGY

For staff and courses of study offered, see special bulletin of graduate work in medicine.

PATHOLOGY

Prerequisites.—Graduate students who desire to take their major or minor work in pathology must present credits in the following subjects: physics, 8 credits; general and organic chemistry, 12 credits; zoology, 6 credits; and a reading knowledge of German.

In addition, students who elect their major work in pathology must present credits for the equivalent of the first two years' work of the Medical School of this University.

For staff and courses of study offered, see special bulletin of graduate work in medicine.

PEDIATRICS

For staff and courses of study offered, see special bulletin of graduate work in medicine.

PHARMACOLOGY AND THERAPEUTICS

For staff and courses of study offered, see special bulletin of graduate work in medicine.

PHILOSOPHY

Professors NORMAN WILDE, DAVID F. SWENSON; Assistant Professor GEORGE P. CONGER.

Prerequisites.—For a major, 18 credits; for a minor, 9 credits.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

100f. HISTORY OF RELIGIONS. Prerequisite: 10 credits. Three credits. II; TThS; 322F. MR. CONGER.

101w. PSYCHOLOGY OF RELIGION. Prerequisite: 10 credits. Three credits. II; TThS; 322F. MR. CONGER.

102s. PHILOSOPHY OF RELIGION. Prerequisite: 10 credits. Three credits. II; TThS; 322F. MR. SWENSON.

103s. ESTHETICS. Prerequisite: 10 credits. Three credits. II; MWF; 322F. MR. SWENSON.

120w. SCANDINAVIAN PHILOSOPHY. Prerequisite: 10 credits. Three credits. 2-3:20; TTh; 316F. MR. SWENSON.

124f. POLITICAL AND SOCIAL ETHICS. Prerequisite: 20 credits in any social science, or 10 in philosophy. Five credits. I; T-S; 322F. MR. WILDE.

129w. MODERN POLITICAL THOUGHT. Prerequisite: 10 credits in philosophy, or 20 credits in any social science. Five credits. I; T-S; 322F. MR. WILDE.

135f-136w. THE PHILOSOPHY OF PLATO. Prerequisite: 10 credits. Six credits; VIII; MWF; 316F. MR. SWENSON.

141f-142w. METAPHYSICS. Prerequisite: 10 credits, including Philosophy 2. Six credits. II; MWF; 316F. MR. SWENSON.

161f-162w-163s. SEMINAR IN PHILOSOPHY. Individual investigation, topics to be determined after consultation with the department. Prerequisite: 20 credits. Nine credits. MR. WILDE, MR. SWENSON, MR. CONGER.

PHYSICS

Professors Henry A. Erikson, John T. Tate, Anthony Zeleny; Associate Professor Louallen F. Miller; Assistant Professors Gregory Breit, Joseph Valasek, John H. Van Vleck.

Prerequisites.—For major work, differential and integral calculus and two years of physics of college grade. For minor work, one year of college physics.

A student majoring in physics is required to take Courses 101 to 111 and 102 to 112 inclusive unless excused by the department upon satisfactory evidence through examination at entrance. A course of general reading as outlined by the department in each individual case is also required.

For the Master's degree a reading knowledge of French or German is required. It is desirable that this requirement be fulfilled before graduate work is begun.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

101f-103w-105s-107f-109w-111s. Theoretical Physics. Designed to supplement the general course and to prepare the student for the more specialized graduate courses. Four lectures a week. Prerequisites: Courses 21, 31, 41, Mathematics 51. Twelve credits. IV; MTWF; 2Ph. Mr. Tate.

102f-104w-106s-108f-110w-112s. Experimental Physics. Comprehensive course extending through two years; laboratory technique and standard methods of precise measurements. This course may be begun any quarter. Two three-hour sessions a week. Prerequisites: Courses 22, 32, 42. Three credits per quarter. (1) V-VII; MW; 2Ph. (2) V-VII; TTh; 2Ph. Mr. Tate, Mr. Zeleny, Mr. Miller, Mr. Valasek, Mr. Power.

115f-117w-119s. Elements of Mathematical Physics. Standard methods involved in the mathematical analysis of physical problems. Three lectures a week. Prerequisites: Course 105, Mathematics 51. Nine credits. Mr. Van Vleck.

114f-116w-118s. Elementary Physical Investigation. Two three-hour session a week. Nine credits. Prerequisites: Course 106, Mathematics 51. Under direction of individual members of staff.

122s. Pyrometry and Heat. Prerequisites: Courses 22 and 42. Three credits. One lecture and two three-hour sessions in the laboratory a week. V-VIII; TTh; 9Ph. Mr. Miller.

132w. Applied Optics. Experimental work on special optical problems. Prerequisite: Course 32. Two three-hour laboratory periods a week. Three credits. VII-VIII; TTh; 3Ph. Mr. Valasek.

142f. Electrical Measurements. Prerequisite: Course 42. Three credits. Three two-hour laboratory sessions a week. See engineering program. Mr. Zeleny.

146w. Electrical Measurements of Precision. Three two-hour laboratory periods a week. Prerequisite: Course 142. Three credits. Mr. Zeleny.

145w-147s. Radioactivity Measurements. Prerequisites: Course 106, Mathematics 51. Nine credits. V-VI; TTh; 15Ph. Mr. Erikson.

COURSES PRIMARILY FOR GRADUATE STUDENTS

201f. Advanced Analytical Mechanics. Kinematics of particles and of rigid bodies; the general principles of dynamics and their application to the motion of particles and of rigid bodies. Application to non-mechanical problems. Three lectures a week. Prerequisite: Physics 101-103-105, Mathematics 51. Three credits. Mr. Van Vleck.

203w. Theory of Elasticity. Analysis of strain and stress; equations of wave motion; applications to sound and to electromagnetic oscillations. Three lectures a week. Prerequisite: Physics 201. Three credits. Mr. Van Vleck.

205s. Hydrodynamics. Equations of Euler and Lagrange. Application to special types of fluid motion; motion of viscous fluid. Three lectures a week. Prerequisite: Physics 201. Three credits. Mr. Van Vleck.

221f. Thermodynamics: Kinetic Theory of Gases. Classical thermodynamics and applications to special problems: statistical mechanics; relation to thermodynamics; theory of effusion, specific heats, dissociation, viscosity, conduction of heat, diffusion, transfer problems in general. Three lectures a week. Prerequisites: Physics 101-103-105; Mathematics 51. Three credits. Mr. Van Vleck.

223w. Theory of Thermal Radiation. Application of thermodynamics and statistical mechanics to thermal radiation; Planck's quantum hypothesis and applications to specific heats and allied problems. Three lectures a week. Prerequisites: Physics 221. Three credits. Mr. Van Vleck.

225s. Theories of Atomic Structure. The quantum theories and their application to the study of X-rays, radioactivity, resonance and ionization potentials, photo-electricity, spectrum series and fine structure; resonance spectra; Stark effect. Three lectures a week. Prerequisites: Physics 221-223. Three credits. Mr. Van Vleck.

231f-233w-235s. Theoretical Optics. Geometrical optics and optical instruments. Theory of interference, diffraction, and polarization. Electron theory of dispersion, absorption, double refraction, optical rotation, magneto- and electro-optics. Radiation and its transformation

and resonance radiation. Theory of moving media. Three lectures a week. Prerequisites: Physics 101-103-105. Mathematics 106-107-108. Mr. Valasek.

241f-243w. Mathematical Theory of Electricity and Magnetism. Fundamental mathematical theorems and processes of analysis applicable to potential theory; electric images; polarized media; magnetism; magnetic shells and their relation to electric currents; current flow in waves and infinite media; dynamical theory of electromagnetism. Three lectures a week. Prerequisites: Physics 101-103-105. Mathematics 106-107-108. Six credits. Mr. Breit.

242f-244w. Theory of Electric Oscillations. Fundamental laws of electrodynamics; free and forced vibrations in electrical circuits, tuning, damping; theory of radio instruments; energy losses in coils, condensers, etc.; electron tubes and circuits containing them; electromagnetic radiation. Three lectures a week. Prerequisites: Physics 101-103-105, Mathematics 106-107-108. Six credits. Mr. Breit.

245s. Fundamentals of Electron Theory. The Maxwell Lorentz equations; solutions in terms of retarded potentials; equations expressing conservation of energy and momentum; electromagnetic mass; systems in uniform rectilinear motion; radiation from electrons. Three lectures a week. Prerequisites: Physics 241-243. Three credits. Mr. Breit.

246s. Measurements of Electrical Oscillations. Determination of characteristic curves of electron tubes; use of wave meter; measurement of high frequency resistance; verification of the laws of oscillating circuits in general. Three two-hour laboratory sessions a week. Prerequisites: Physics 242-244. Three credits. Mr. Breit.

247f. Theory of Relativity. Historical survey; the special theory; Minkowski's four dimensional analysis; application to electromagnetic theory; determination of equations of motion of electrons and applications to gravitation; the general theory; theory of tensors; Einstein's law of gravitation with application. Three lectures a week. Prerequisites: Physics 241-243-245, Mathematics 106-107-108. Three credits. Mr. Breit.

248w-249s. Electron Theory of Matter. Conduction of electricity in metals and allied phenomena; electromagnetic theory and heat radiation; thermionics; atomic structure; theory of diamagnetism; theory of paramagnetism; Weiss's theory of ferromagnetism. Three lectures a week. Prerequisite: Physics 247. Six credits. Mr. Breit.

252f-254w-256s. Research. Under the special direction of individual members of the staff.

261f-263w-265s. SEMINAR. Study of present-day problems in physics. One hour a week. Open to those who are doing graduate work in physics. Three credits. MR. TATE.

PHYSIOLOGY AND PHYSIOLOGIC CHEMISTRY

Prerequisites.—The Department of Physiology is well equipped for the various types of physiologic investigation. The library facilities are good.

For a minor in physiology, general zoology, general and organic chemistry, and college physics are prerequisites. (In exceptional cases high school physics may be accepted.) For a major, physical chemistry is desirable.

In addition, each student majoring in physiology or physiologic chemistry must have had the general courses, Physiology 100, 101, 103, 104, or the equivalent.

For staff and courses of study offered, see special bulletin of graduate work in medicine.

PLANT-BREEDING

Plant-breeding may be elected as a field for either major or minor work. For prerequisites for specialization and statement of courses of study see announcement under Agronomy and Farm Management.

PLANT PATHOLOGY AND BOTANY

Professors EDWARD M. FREEMAN, ELVIN C. STAKMAN; Assistant Professor JULIAN G. LEACH.

NOTE.—For courses in botany including plant physiology see Department of Botany.

Prerequisites.—The minimum requirement is (a) three years (27 credits) in botany, one year (9 credits) of which shall be mycology; (b) general bacteriology one quarter (4 credits) or some equivalent; (c) one year (9 credits) in plant pathology—preferably two years (18 credits).

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

105f-106w-107s. MYCOLOGY. Morphology, taxonomy, and biology of fungi. Lecture, laboratory, greenhouse, and field work. Prerequisites: Botany 7 and 11 or equivalent. Three credits per quarter. I, II; MWF; 1, 32 PP. MISS DOSDALL.

108f. METHODS. Plant pathological methods, including mycological and bacteriological technique. Lectures, laboratory, field, and greenhouse work. Special problems. Prerequisites: Course 1 or 10 and Bacteriology 6. Three credits per quarter. Ar. 1, 2PP. MR. LEACH.

110w. Principles of Pathology. Comparative biology of plant pathogens; pathological plant anatomy, parasitism, biologic specialization, resistance, and immunity. Prerequisites: Course 1 or 10 and Bacteriology 6. Three credits. III, IV; MWF; 1, 2PP. Mr. Stakman.

111w,su. Diseases of Field Crops. Symptomatology, etiology, and practical methods of control. Laboratory, lecture, and field work. Prerequisite: Course 1 or 10. VI, VII; MWF; 1, 2PP. Mr. Stakman.

112s. Diseases of Fruit Crops. Especially those important in Minnesota. Laboratory, lecture, and greenhouse work. Three credits. VI, VII; MWF; 1, 2PP. (Given in alternate years; not offered in 1923-24.) Mr. Leach.

113s. Diseases of Vegetable Crops. Diseases of potatoes and other vegetable crops. Lecture, reference, laboratory, and greenhouse work. Three credits. VI, VII; MWF; 1, 2PP. (Given in alternate years; offered in 1923-24.) Mr. Leach.

114w. Advanced Forest Pathology. Wood rots, including a study of the deterioration of wood products caused by fungi. Lectures, laboratory, and greenhouse work. Three credits. VIII, IX; MWF; 1, 2PP. (Given in alternate years; offered in 1923-24.) Mr. Stakman, Mr. Leach.

COURSES PRIMARILY FOR GRADUATE STUDENTS

203f-204w-205s. Special Problems. Special assignment of work in laboratory and field problems in pathological research. Mr. Freeman, Mr. Stakman.

207f-208w-209s. Research in Mycology. Research work along following suggested lines: taxonomy of natural groups; fungous flora of particular regions, localities, or habitats; investigation of fungi involved in special industrial or natural processes; morphology or physiology of special forms. Prerequisite: Course 105-106-107. For minor or major. Three credits per quarter. Mr. Freeman, Mr. Stakman.

211. History of Plant Pathology. Development of important mycological, pathological, and physiological researches; historical basis of modern science of plant pathology. Two credits per quarter. Mr. Stakman.

213. Seminar. Assigned topics with special reference to current pathological problems. Historical review of literature on special problems and critical study of current literature. Two credits per quarter. Mr. Stakman.

POLITICAL SCIENCE

Professors CEPHAS D. ALLIN, FREDERIC H. BASS (Engineering), JEREMIAH S. YOUNG, ROY G. BLAKEY (Economics), SOLON J. BUCK (History), ALVIN H. HANSEN (Economics), S. B. HARDING (History), NORMAN WILDE (Philosophy); Associate Professors WILLIAM ANDERSON, JOHN M. GAUS, LESTER B. SHIPPEE (History); Assistant Professors MORRIS B. LAMBIE, HAROLD S. QUIGLEY.

Prerequisites.—For major work, 18 credits; for minor work, 13 credits.

Professional courses.—The attention of those who are preparing themselves for the public service is called to the special training courses outlined in the bulletin of the College of Science, Literature, and the Arts. Further information may be had from the chairman of the department.

Bureau for Research in Government.—This bureau is organized to conduct and direct special investigations into practical political and administrative problems, national, state, and local. Mr Anderson will act as director, but all members of the staff will take part in the work of the bureau. Advanced and graduate students are strongly urged to take advantage of its facilities.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

107-108. EUROPE, 1848-1914. Identical with History 107-108.

109. ENGLISH HISTORY, 1815-1920. Identical with History 109-110. MR. HARDING.

111. MUNICIPAL FUNCTIONS. III; TThS; 4F. MR. ANDERSON.

113. MUNICIPAL PROBLEMS. A specialized course in modern legal, administrative and functional problems of cities. II; MWF; 213B. MR. ANDERSON.

115. MUNICIPAL CORPORATIONS. III; TThS; 204F. MR. ANDERSON.

117. MUNICIPAL ENGINEERING. Identical with Civil Engineering 53.3. MR. BASS.

121-122. INTERNATIONAL LAW. With especial attention to diplomatic and consular practice. IV; MWF; 15F. MR. ALLIN.

123. INTERNATIONAL ORGANIZATION. Systems of international relations. International administrative organizations, and political guarantees of the past with a detailed study of the League of Nations. VII; MWF; 15F. MR. QUIGLEY.

124. PROBLEMS IN INTERNATIONAL LAW. Intensive study of the solution of selected international controversies by national and international courts, arbitration tribunals, and diplomatic conferences. (Not offered in 1923-24.)

125. American Diplomatic History. Principles and policies guiding American diplomacy in its stages of development as well as to the methods pursued and the personalities of American diplomats. III; MWF; 15F.

127. American Foreign Relations. Such topics as the Monroe Doctrine, freedom of the seas, the "open door," arbitration, and disarmament will be considered with particular reference to the future policy of the United States. III; MWF; 15F.

131. Public Administration. Sources of administrative power; administrative areas; organization of departments; personnel, and related civil service problems including classification, training, appointment, promotion, salary determination and superannuation; the budget; purchasing; control over administration; public service as a career. VII; MWF; 25F. Mr. Lambie.

133. Problems of Public Administration. Organization of departments and distribution of functions relating to particular problems of public administration including public health, finance, education, public works, safety, welfare, commerce, and agriculture. VII; MWF; 25F. Mr. Lambie.

136f. Far Eastern Politics. The principal factors in the social and political life of Japan and China; their relations with each other and with western powers. VII; MWF; 15F. Mr. Quigley.

137w. Far Eastern Diplomacy. VII; MWF; 15F. Mr. Quigley.

141. Problems in State Government and Constitutional Law. A selected group of current problems in state government will be studied intensively in their constitutional and political aspects. VI; MWF; 213MA. (Not offered in 1923-24.)

145. Legislative Power and Methods. Source and scope of the legislative power; methods used by legislative bodies; current political questions; formulation and defense of legislative bills. II; TThS; 102MA. (Not offered in 1923-24.) Mr. Young.

146-147.† Constitutional History of the United States. Identical with History 146-147. Mr. Shippee.

151. Constitutional Law: The American Federal System. Judicial interpretation of the constitution; power of judicial review; separation of governmental powers; relation of state and national governments; construction of national powers; jurisdiction of courts. Ar.

152. Constitutional Law: Fundamental Rights and Immunities. Privileges and immunities of citizenship; protection of civil and political rights; the obligation of contracts; due process of law and equal protection of the law. Ar.

153. The West in American Politics Since 1865. Identical with History.

155. Comparative Administrative Law. Administration as a science; analysis of the administrative systems of the United States, England, France, and Germany with special reference to the law of officers, the merit system, and special administrative tribunals. II; TThS; 311F. Mr. Young.

157. Police Power. Nature of the police power; constitutional aspects of social and economic legislation, including safety, order, morals, and protection against business fraud and oppression; the fundamental rights under the police power. II; TThS; 102B. Mr. Young.

158. Government and Business. Governmental powers; protection against fraud and oppression; restraint of trade and manipulation of prices; protection of debtors; business affected with a public interest; combination of laborers; corporations; compulsory benefits; conservation of natural wealth; vested rights; confiscatory legislation. II; TThS; 124F. Mr. Young.

161. Comparative Federal Government. Ancient and modern federal unions. IV; MWF; 15F. Mr. Allin.

165. Law and Custom of the English Constitution. Legal and political aspects of the English constitution. II; MWF; 15F. Mr. Allin. 153. Mr. Buck.

166. Government of the British Empire. Organization, working and international status of the Imperial and Dominion governments. II; MWF; 15F. Mr. Allin.

167. British Politics. Parties, party leaders, and policies. The relation of English and imperial policies. II; MWF; 15F. Mr. Allin.

169. The Labor and Socialist Movement in Europe. Identical with Economics 169. Mr. Hansen.

181. Modern Political Thought. Same as Philosophy 129. I; TWThFS; 322F. Mr. Wilde.

185. Political and Social Ethics. Same as Philosophy 124. I; TWThFS; 322F. Mr. Wilde.

191-192. Public Finance. Identical with Economics 191-192. Mr. Blakey.

193. State and Local Taxation. Identical with Economics 193. Mr. Blakey.

COURSES PRIMARILY FOR GRADUATE STUDENTS

201-202-203. Seminar in Public Law. Mr. Young and others.

211-212-213. Seminar in Modern Government and Political Theory. Mr. Allin and others.

221-222-223. Seminar in Local Government and Administration. Mr. Anderson and others.

Note.—A student registered in a seminar course will be expected to complete a satisfactory piece of research before receiving credit for the course. The Bureau for Research in Government is designed to give all possible assistance in the conducting of such research, but is not intended to relieve the student of his personal responsibility.

PSYCHOLOGY

Professors Richard M. Elliott, William S. Foster, Donald G. Paterson; Associate Professors Karl S. Lashley, Herbert Woodrow; Lecturer Harry M. Johnson.

Prerequisites.—For either major or minor work, 12 credits.

101f-102w†-103s. Experimental Psychology. The theory and technique of the leading methods of experimental investigation in human psychology. Individual minor research problems in the third quarter. One lecture, four laboratory hours per week. Six or nine credits. VII; MWF; VIII; WF; 116Psy. Mr. Foster, Mr. Johnson.

108f-109w.† Advanced General Psychology. The laws of the normal, adult mind, based upon the study of experimental results. Lectures, recitations, and reports. Six credits. VIII; M. IX; MW; 116Psy Mr. Woodrow, Miss Ludgate.

114w-115s.† Human Behavior. An analysis of the development and organization of human behavior. Consciousness or mind, as a property of the living body, is discussed in its dependence upon response. Six credits. II; TThS; 109Psy. Mr. Elliott.

121f-122w†-123s. Neuropsychology. The functions of the nervous system in behavior. Neural basis of reflex, instinct, and habit. Physiology of motivation. Individual investigation of special problem in third quarter. One lecture and five laboratory hours per week. Six or nine credits. VII; VIII; MWF; 109Psy. Mr. Lashley.

124f. Psychology of Learning. Critique of current theories concerning the nature of the learning process. Problems and methods bearing upon the physiology of learning. Not open to students who take Neuropsychology. Three credits. IV; MWF; 109Psy. Mr. Lashley.

125f-126w.† Psychology of Individual Differences. Experimental and statistical study of the influence of sex, race, immediate ancestry, and environment in the causation of individual differences in mental traits. Each student participates in investigation of problems and in analysis of results. Six credits. II; MWF; 109Psy. Mr. Woodrow.

127s. Social Psychology. An examination of the behavior of men in groups, and of some important social institutions, as determined by human motives and traditions. Three credits. II; MWF; 109Psy. Mr. Bird.

144w-145s.† Abnormal Psychology. Systematic review of psychiatry in relation to normal behavior. Types of social maladjustment; delinquency, criminality, fanaticism. Psychology of creative ability. The organization of personality as revealed by studies in psychopathology. Six credits. IV; MWF; 109Psy. Mr. Lashley.

COURSES PRIMARILY FOR GRADUATE STUDENTS

200f-201w.† Seminar in the History of Psychology. Selected topics from the history of psychology. Open to advanced students with permission of the instructor. Three or six credits in proportion to work done. Mr. Foster. (Not offered in 1923-24.)

205s. Advanced Differential Psychology. Three credits. Mr. Paterson.

206-207-208. Research in Animal Behavior.

210f-211w-212s. Research Problems. Laboratory investigations. Open to graduate students only. Mr. Elliott, Mr. Foster, Mr. Lashley, Mr. Paterson, Mr. Woodrow, Mr. Johnson.

215f-216w-217s.† Seminar in Physiological Psychology. Fortnightly meetings attended by teaching staff and advanced students for discussion of some of the fundamental problems of behavior and for reports of research in progress in the laboratory. Three credits. Alternate Th. 7:15-9:15 p.m. Mr. Lashley.

220f-221w-222s.† Journal Club and Seminar. Advanced students meet every other week for reports on current publications and discussion of contemporary trends in psychology and related sciences. Attendance of graduate students who are candidates for degrees is required. One credit per quarter.

ROMANCE LANGUAGES

Professors Everett W. Olmsted, Francis B. Barton, Irville C. LeCompte, Colbert Searles; Associate Professor Ruth S. Phelps[1]; Assistant Professors Joseph E. Gillet, Eugene F. Parker, Gustave van Roosbroeck[1]; Instructor Arturo Torres-Rioseco.

[1] Absent on leave 1923-24.

Prerequisites.—For major work, 27 Senior College credits or equivalent; for minor work, 18 Senior College credits or equivalent. Candidates for Master's degree must also have a reading knowledge of at least one other modern language. Candidates for the Doctor's degree must have had at least two years' work in Latin, and are required to take also the course in medieval Latin in the Latin Department. A reading knowledge of a second Romance language and of German is also required.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

FRENCH

100w-101s. DICTION FRANÇAISE. Dissertations littéraires par le discours. Leçons sur des textes en prose et en vers. Exercices oraux de diction, de syntaxe, et de vocabulaire. VIII; MWF; 227F.

103-104-105.† FRENCH SYNTAX AND COMPOSITION. Special studies in characteristic problems of French syntax. V; F; 203F. MR. BARTON.

115-116-117.† FRENCH LITERATURE: SEVENTEENTH CENTURY. Influence of the literary salons. Development of French prose. Perfection of French dramatic art by Corneille, Racine, and Molière. Reading, discussions, reports based upon collateral reading. III; TThS; 201F. MR. SEARLES.

118-119-120.† FRENCH LITERATURE: EIGHTEENTH CENTURY. Philosophic movement: Bayle, Fontenelle, Montesquieu, Voltaire, l'Encyclopédie, Rosseau. Literature: poetry, tragedy, comedy, novel. Reading, discussions, reports, based upon collateral reading. III; MWF; 110F. MR. PARKER.

121-122-123.† FRENCH LITERATURE: SIXTEENTH CENTURY. Forerunners of the Renaissance: Marot and l'Ecole Lyonnaise. The Renaissance movement and the reformation, Rabelais, Calvin and the Pléiade and its successors; Montaigne; the situation at the close of the century. (Not offered in 1923-24.)

141-142-143.† REALISTIC NOVEL: NINETEENTH CENTURY. A study of realism with especial reference to the novel. Flaubert, Maupassant, Zola, etc. Alternates with 159-160-161. VII; TTh; 203F. MR. LECOMPTE.

150-151-152.† FRENCH DRAMATIC LITERATURE. A study of the development of dramatic literature in France from the classical period to the present time. Alternates with 153-154-155. III; TTh; 203F. MR. OLMSTED.

153-154-155.† FRENCH LYRIC POETRY. Principles of French prosody. A study of the evolution of French lyric poetry. Alternates with 150-151-152. (Not offered in 1923-24.) MR. OLMSTED.

159-160-161.† FRENCH CRITICISM. A study of the masters of French criticism. Alternates with 141-142-143. (Not offered in 1923-24.) MR. LECOMPTE.

171-172-173.† Explication des Textes. An analytical and critical study of French texts, in which particular attention is given to style, thought, and diction. The course is conducted in French. (Not offered in 1923-24.)

174-175-176.† Lectures in French. Le Roman français contemporain. IX; TTh; 201F. (Not offered in 1923-24.) Mr. van Roosbroeck.

191-192-193.† Research Methods and Material. (Not offered in 1923-24.) Mr. van Roosbroeck.

Spanish

100-101-102.† Spanish Oral Diction. Oral dissertations on assigned subjects. Exercises in diction, syntax, and vocabulary.

103-104-105.† Spanish Syntax. Special studies in characteristic problems of Spanish syntax. VI; T; 230F. Mr. Torres.

115-116-117.† Spanish Literature: Seventeenth Century. Alternates with 156-157-158. IV; TS; 227F. (Not offered in 1923-24.)

141-142-143.† Spanish Novel. The development of Spanish fiction from the picaresque novel to that of the present day. (Not offered in 1923-24.)

150-151-152.† Spanish Dramatic Literature. A general survey of Spanish dramatic literature with especial attention to the Golden Age. (Not offered in 1923-24.)

156-157-158.† Spanish Literature: Sixteenth Century. Alternates with 115-116-117. (Not offered in 1923-24.)

159-160-161.† Cervantes. A study of his life and works. Attention will be centered upon *Don Quixote* and the *Novelas Exemplares*. IV; TS; 227F. Mr. Gillet.

174-175-176.† Lectures in Spanish. Subjects to be announced. IX; TTh; 202F. Mr. Torres.

Italian

159-160-161.† Dante, Petrarch, Boccaccio. An introduction to their works. The three cantiche of the *Divina Commedia* are read, one each year in rotation, together with a number of the canzoni, and sonnets of Petrarch, and portions of the *Decameron*. IV; MW; 213F. Mr. Malone.

162-163-164.† Dante in English. Lectures; reading and discussion of the *New Life*, and two cantiche of the *Divine Comedy* not read in 159-160-161. Private reading of one other work. IV; F; 213F. Mr. Malone.

COURSES PRIMARILY FOR GRADUATE STUDENTS

201f-202w-203s. Old French Phonology and Morphology. Lectures on the origin and development of the French language, with practical exercises and reports on assigned topics. Six credits. Mr. LeCompte.

204f-205w-206s. Reading in Old French Literature. An introductory course in the reading of Old French. Different types of literature will be read and their origin and development discussed. A certain amount of collateral reading required. Three credits. Mr. LeCompte.

207f-208w-209s. Old Provençal. Reading in early provençal literature with special attention to the poetry of the troubadours. Six credits. Mr. LeCompte.

222f-223w-224s. Seminar in Modern French Literature. Six credits. VIII; IX; Th; 203F. Mr. Searles.

241f-242w-243s. Old Spanish Philology. Two credits. Mr. Gillet.

244f-245w-246s. Old Spanish Literature. Every year a different genre is studied, such as the epic. Subject to be decided by agreement of students. Two credits. Mr. Gillet.

250f-251w-252s. Spanish Seminar. Six credits. VIII, IX; F; 203F. Mr. Olmsted.

259f-260w-261s. Research in Romance Languages. Credit depends upon amount of work accomplished.

SCANDINAVIAN

Professors Gisle Bothne, Andrew A. Stomberg.

Prerequisites.—For major work, 18 credits; for minor work, 6 credits in the department. All required foreign language credits for the Master's degree in this department may be in either Norwegian, Swedish, or Danish.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

101f-102w-103s. Modern Norwegian Literature. From 1814 to the present day. Prerequisites: Scandinavian 1-2 and 3-4. Nine credits. II; TThS. Mr. Bothne.

104f-105w-106s. Modern Scandinavian History. Knowledge of Scandinavian not required. Nine credits. IV; MWF. Mr. Stomberg.

107f-108w-109s. Modern Swedish Literature. The Swedish novel. Study of a selected list of Swedish classics. Nine credits. V; MWF. Mr. Stomberg.

117w-118s. Earlier Norwegian Literature. Prerequisite: Scandinavian 102. Five credits. III; TS. Mr. Bothne.

110w. Ibsen. Prerequisite: Scandinavian 101-102-103. Three credits. Mr. Bothne.

111f-112w-113s. Old Norse (Icelandic). Grammar and reading. Gunnlaug's Saga Ormstungu. Six credits. V; TTh. Mr. Bothne.

114f. Strindberg. Prerequisite: Scandinavian 107f-108w-109s. Three credits. Mr. Stomberg.

131f-132w-133s. Danish Literature of the Nineteenth Century. From Oehlenschläger to the present time. Nine credits. Mr. Bothne.

134f-135w. The Landsmaal Movement and Literature. From Aasen to Garborg. (Not offered in 1923-24.) Mr. Bothne.

136s. Björnson. A study of his activity as a central figure in modern Norway. Mr. Bothne.

COURSES PRIMARILY FOR GRADUATE STUDENTS

201-202-203. Seminar in History of Scandinavian Languages. Mr. Bothne.

204-205-206. Etymological Studies. Mr. Bothne.

209-210. Seminar in Modern Swedish Language and Literature. The course is based upon Schuck and Warburg's *Illustrated Svensk Litteraturhistoria* and includes a study of special authors. Nine credits. Mr. Stomberg.

215-216-217. Seminar in Norwegian Literature. The various phases of the cultural development of modern Norway are discussed. The complete works of Björnson or Ibsen are especially studied. Also Holborg and the eighteenth century. Mr. Bothne.

SOCIOLOGY AND SOCIAL WORK

Professors F. Stuart Chapin, Luther L. Bernard; Associate Professor Manuel C. Elmer; Assistant Professors Ross L. Finney, Gustav A. Lundquist; Special Lecturers Frank J. Bruno, Emil G. Steger, William W. Hodson.

Prerequisites.—For major work, 18 quarter credits; for minor work, 12 credits.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

100f. Social Psychology. Primarily for sociology students. The social attitudes; their development and modification under social pressures; the interactions of individuals and groups. II; TThS; 9F. Mr. Bernard.